

No. 4.— *Mammalian Life Histories from
Barro Colorado Island, Panama*

BY ROBERT K. ENDERS

INTRODUCTION

The following contributions to the life histories of the mammals occurring on Barro Colorado Island and adjacent portions of the Canal Zone and the Republic of Panama are based on materials collected during four periods of study beginning in 1929 and extending to 1935.

Work was initiated June 19 and pursued until August 11, 1929. The second period of study extended from November 11, 1930, to March 3, 1931; while the third covered the period between February 20 and July 4, 1932. All of the time was spent on the Island with but occasional trips to the mainland until March 12, 1932, when a week was spent at the southern half of the Zone. On May 17 the base of operations was transferred to Summit while work was carried on in the new Forest Preserve and at Las Cascades Plantation, as well as in the Experimental Gardens. Headquarters were again moved on June 1 — this time to Alhajuela — for a period of four weeks. A fourth trip was made to study the areas about Salamanca on the Pequeni River and Peluca on the Boqueron River of the Chagres drainage system.

The studies extending from 1930 to 1932 were made while the writer was a fellow of the National Research Council working under the direction of Dr. Carl G. Hartman of the Department of Embryology, Carnegie Institution of Washington. The problem assigned was a study of the reproduction of *Marmosa*, involving a study of the life history of the genus. Dr. Hartman encouraged the collection of data on other species whenever possible. The last trip was made possible by a grant-in-aid from the National Research Council, having as its object the collection of series of animals for anatomical research, and the observation of faunal changes subsequent to the flooding of the rivers caused by the closing of Madden Dam.

Throughout these studies constant reference will be made to the outstanding work of E. A. Goldman, particularly his "Mammals of Panama," to which the reader is referred for a summary of the work done up to 1920. Other works published since that date to which frequent reference is made include Allen and Barbour, "Mammals

from Darien;" Chapman, "My Tropical Air Castle;" and Standley, "Flora of Barro Colorado Island, Panama."

Assistance of great value was received from so many persons that it is impossible to mention them by name, but to whom, however, the writer expresses his sincere thanks. Special acknowledgment is due first to Thomas Barbour, Director of the Institute for Research in Tropical America for his unfailing support; to A. G. Ruthven who encouraged the writer's first interest in this work; to L. R. Dice for his encouragement and support; to A. B. Howell for identification of some of the specimens, and constant encouragement; to James Zetek and his faithful staff for their cooperation; to J. B. Shropshire for aid in securing many of the mammals observed in captivity; to Ray Carpenter for many observations; to Otis Shattuck and Walter W. Boyd for photographs; and to Frank M. Chapman, who, through his personality and writings has served as an inspiration to the author. The United Fruit Company, through the Institute for Research in Tropical America, has always extended to the writer special rates for all trips. No one can work in the Canal Zone without being beholden to the officials of the Canal for many favors.

Financial support was received from the National Research Council; the William P. Harris, Jr. Fund, Museum of Zoölogy, University of Michigan; and Thomas Barbour. The U. S. National Museum furnished much collecting equipment. Acknowledgment is also made for the not inconsiderable aid of Major Goldman in the identification of some of the rarer rodents; also to the U. S. Biological Survey for the loan of material in connection with identification.

The nomenclature used throughout follows Miller, "List of North American Recent Mammals," and Standley, "Flora of Barro Colorado Island, Panama."

The following account of Barro Colorado Island is taken from various sources, chiefly Kenoyer (1929), some of which is quoted verbatim, as well as Standley (1928), Chapman (1929), Bennett (1929) and the Annual Reports of the Laboratory.

Barro Colorado was formed in 1914 when Gatun Dam backed up the waters of the Chagres River, making the lake that constitutes the central part of the Panama Canal. Gatun Lake covers 164 sq. mi. (420 sq. km.), has a maximum depth of 90 ft. (27.4 m.); its surface is 85 ft. (25.9 m.) above sea level, and is dotted with islands, the largest of which is Barro Colorado. This island lies between 9° 8' and 9° 11' north latitude, and between 79° 49' and 79° 53' west longitude. Its greatest length and its greatest width are each approximately 3 mi.

(4.8 km.), and it has an area of 6.64 sq. mi. There are more than forty miles of shore line. The highest point on the Island is 537 feet above sea level, an altitude of 452 feet above the lake. The Island was set aside in 1923 by the Governor of the Canal Zone as a biological reserve and the few small areas previously cultivated were then abandoned.

The annual rainfall (1926-1930) is 100.10 inches of which only 7.08 inches fell during the first four months of the year which constitute the dry season. With rare exceptions the temperature ranges from 70° to 90° F. The mean daily temperature remains practically the same from month to month; while the diurnal range varies from 5° to 15°. The relative humidity fluctuates between 77% in the dry season to 88% in June, July and August. The soil is Frijoles Clay, a dark red clay, moderately friable, susceptible to desiccation, hardening and cracking when very dry, and varying from 2 to 5 ft. in thickness. There are many outcrops of rock, chiefly Bohio conglomerate.

The following account and accompanying map are based upon the labors of many individuals. Thanks are chiefly due to Ray Carpenter who originated the idea and upon whom fell much of the labor of determining the limits of the various types; also to Frank M. Chapman for criticism and suggestions. Enlarged sections of an aerial photograph made by the U. S. Army Air Service were used as a check on the work in the forest. The writer begs to draw the attention of the reader to the fact that the map makes no pretense at being anything but a convenient method of outlining the types of forest which all but cover Barro Colorado Island, and that the criterion used over much of the area is that of tree size. The map is neither ecologic nor floristic except secondarily, nor is it intended to be.

"About half of it (the forest covering of the Island), that farthest from the Canal, is apparently primeval forest, although Standley (1927) points out that in a region which has been for over 400 years an important trade route it is difficult to prove that a given tract of land has not at some time been cleared and put under cultivation. The other half is occupied mainly by secondary forest, the largest trees of which scarcely exceed a foot in diameter at the base. Apparently it has become forested from a cleared condition of about fifty years ago." (Kenoyer, 1929, p. 201.)

In mapping, four types are recognized and illustrated in addition to the clearings. These clearings are the laboratory, the plantation, the new plantation, the areas about the two range lights at the end of Miller Trail, and about the tower. The area near the tower is permitted to grow up higher between cuttings than the other areas.

Although insignificant in area, these clearings are important as they are occupied by both plant and animal forms that do not occur in the other areas. Moreover, they may be considered as natural, for such small, isolated areas of clearing have occurred in the forest for many centuries, ever since the inhabitants of the region have practiced the "milpa" system of farming.

Next might be mentioned the areas that were cleared as late as 1920-1923. One such area occupies the neck and much of the end of the peninsula on which stands Bangs House, while another covers the region about the guard shanty. A third area which contains trees somewhat older lies on either side of Wheeler Trail from Stations 6 to 8.5, and from 10 to the tower clearing. This area extends as far as Wheeler 16, Armour 4, Zetek 1, while the other end is crossed by the cut-off from Wheeler to Miller. This is by far the largest area of this type and lies near the center of the Island.

It is here that an old French dump cart had been built into a stone furnace. From this construction and the bottles near by one can surmise the use to which it was put. The sugar cane which supplied the fermented juice was probably produced near at hand as cane is too heavy and bulky to transport over forest trails. Thus, the clearings cannot have been abandoned for over fifty years and probably only thirty. An abandoned cocoa plantation on Peña Blanca supports trees that are still older, as well as the large trees under the shade of which the cocoa grew.

The forest that covers the eastern and northern as well as other portions and much of the shore of the Island has been growing more or less undisturbed for a longer period as the trees are larger, in some areas approaching ten to twelve inches in diameter. Cultivation may have been abandoned over much of these areas as long as fifty years ago, but persisted until a later date in a few small clearings.

The fourth type is found in the oldest forests and differs from it chiefly by the abundance of palm trees. This type is indicated because it is avoided by the truly arboreal species of mammals.

The "primeval forest" is the most impressive type for the trees attain considerable size although the density of the stand is not as impressive as in northern forests. The ground is remarkably free from undergrowth over the level areas.

Although the second growth becomes very dry during the dry season, and some of the larger trees shed their leaves, the forest does not become brown and desiccated as do similar areas on the Pacific side of the Zone.

An observer, familiar with forest life in temperate regions, is astounded at both the many species and the large numbers of individuals supported by a forest such as that growing on Barro Colorado Island. Thus far fifty-three species of mammals have been recorded from the Island, and there are, doubtless, more. The large number of individuals supported by the area, particularly that of the larger species, is truly remarkable.

The explanation frequently given in this case is that, as Gatun Dam filled, the mammals were forced to take refuge on higher ground and were thus marooned on the Island. Like Chapman (1929, p. 5), the writer very much doubts this easy explanation, and adds to the arguments advanced by that writer the fact that an unnatural concentration forced upon a fauna from 1910 to 1914 would not persist in 1932. There is, broadly speaking, no sign of a diminution of the numbers of mammals. On the contrary, some, such as the Coati, have very definitely increased.

In such a forest the food supply does not fluctuate as it does in a region of more decided seasonal changes. The rain forest supplies leaves, fruit, nuts, and roots at all seasons of the year, not always with the same lavishness, but abundantly enough to carry a large population. Some of the carnivores eat fruit, and many other species of mammals are omnivorous which increases the carrying power of the area.

Nowhere in the writer's experience has he encountered as great a diversity of habitat, a greater concentration of many species of mammals, as occurs on the 4,000 acres or so that comprise Barro Colorado Island.

That a similar concentration of large mammals is not found elsewhere in the Canal Zone nor in the adjacent portions of the Republic can be explained upon the basis of the clearing of the land and the constant hunting to which all large mammals are subjected. The concentration of rodents, on the other hand, is more marked when conditions more favorable to them are brought about by human occupation. Hunting without clearing is effective in destroying the larger mammals even though the smaller arboreal forms persist.

How many individuals of each of the species of mammals do we have on the Island? Except in the case of the Howler Monkey where the careful, accurate work of Carpenter has given us the numbers of this unique animal we have no check.

Casual observations cannot be relied upon. So many of the mammals are able to escape discovery by taking to or staying under cover

that hunting does not give one a true cross section. Moreover, many of the mammals are nocturnal, a number are arboreal, and where the forest canopy is about ninety feet above one, the observer has scant opportunity for detecting their presence. Not all nocturnal mammals can be "shined" and specific determinations are difficult even using two powerful lights. The same difficulty is experienced with many species the eyes of which do reflect the light. Chance, too, is a factor.

Traps are no more accurate. In the first place, it is difficult to find places to set traps, particularly for mammals that are arboreal or semi-arboreal. Despite the fact that many species are omnivorous, the problem of bait is acute because of ants. Moreover, when food is abundant, as it is at various seasons of the year, baiting is of no use, as no bait that can be offered is more attractive than certain natural foods.

Observations made at one season of the year may not be applicable a few weeks later. Not only do the various species shift their feeding grounds with the ripening of certain fruits and nuts, but there are, superimposed upon shifts in range due to changing conditions in food supply, shifts caused by the changes of season. This may be illustrated by the shifts in wallows of the tapir and peccaries, to cite a conspicuous, direct effect of changing hydrographic conditions; or the changes in distribution of the Talamanca Rice Rat, or the Pygmy Rice Rat, which are less conspicuous but just as definite. And the carnivores follow their prey in these shifts.

Thus it comes about that one may be led to believe that a certain species is all too abundant at one time and then to wonder why all have disappeared when a change in food supply or season or both brings about a shift away from what the observer has come to consider their usual haunts. As an example of one of these shifts, the conditions at the end of March 1932, may be cited. Some of the foods maturing in March flower in November. The November before, 30.04 inches of rain fell which might have interfered with fertilization, or destroyed the young fruit. Regardless of the cause, the almendro crop which is an important source of food at this time of year for many species of mammals failed, and food was very scarce. Mammals such as the White-lipped Peccary were forced into the clearing for food; the Collared Peccary ate foods usually scorned. Coati were abundant, as were *Didelphis*. Some banana trees were pushed over and the green bananas eaten; pineapples and papaya were eaten before ripening. Out of a dozen traps, six would show the effect of tooth or claw because some large animal had attempted to get at the bait within or the captured specimen. A large live trap, banana

baited, was sprung almost every night. Coati thus taken were deported to the other side of Gatun Lake without any apparent diminution of the original numbers.

Then conditions changed almost overnight. No small mammals entered the traps, neither did large mammals disturb them. Coati, peccary, *Didelphis*, and fruit-eating bats were nowhere to be seen. Only small rodents were left about the clearing; everything else, apparently, having moved. Trap lines along the streams yielded nothing but Spiny Rats, and few of them. Imperfect bunches of bananas discarded in the clearing were not consumed. The finca was deserted.

Having observed such a swift shift before, it was not such a great surprise to the writer. The mammals had found a food supply in the forest. When a similar change took place in December, 1930, it was due to the ripening of Almendro nuts and camito or Star-apple. In 1931-32, both these foods failed so the pressure upon the clearing became greater and was prolonged by several months. Thus, when, at the end of March, 1932, the figs began to ripen, the mammals left the clearing for their usual feeding grounds. Within a week, conditions had changed and the animals followed the food supply. Not until conditions altered with the advancing rainy season would the mammals again be abundant about the clearing.

With these changes in mind the reader will understand some of the difficulties encountered in attempting to determine the numbers of mammals. Nevertheless, wherever an estimate of numbers is possible, it will be given together with the basis upon which the estimate is made. This appears to be the only method possible with our present knowledge.

The problems of mammal distribution on the Island are intricately associated with food, the distribution of primary and secondary forest, scrub and clearing, water courses, and season — chiefly insofar as season affects rainfall and food supply. These factors are indicated where known.

OPOSSUM

Didelphis marsupialis etensis

The Eten Opossum is easily recognized, as it looks, at first glance, like the Virginia Opossum. It differs from the northern form in many characteristics, having, for instance, seven mammae, but like that opossum, two color phases of this species occupy the same territory.

It is nocturnal. In looks, intelligence and some few habits, the two species are much alike, but the gait of the Eten Opossum is more rapid. Also, only a few individuals will "play 'possum," while most are willing, savage fighters. Full grown males, some of which weigh 2.1 kilos, can put up a very effective defense. One such individual was taken in a live trap, a hind leg snared, and then removed from the trap. He repeatedly charged the man holding the rope. He was then grasped by the scruff of the neck and lifted from the ground, and, still fighting, was carried into the laboratory where an ether cone was applied while the animal was held on the floor. In his attempts to escape the cone and the grip on his neck, he pulled out all of the nails on his forepaws. In addition to the four feet, the teeth are used for holding to a vine or similar object when an attempt to dislodge them is made.

Not only are they willing fighters, but they move much more rapidly than the Virginia Opossum. Individuals that have not been exhausted by struggling in a steel trap may be quiet for a moment after being released, but soon dash off at a very rapid gait. In no case was the writer able to catch up to and pick up a fully grown individual as he has done with the Virginia Opossum — partly because of the speed, partly on account of the very active defense with which the retreat is covered when the pursuer comes close enough to touch them. They run well, climb well, and are very much at home among the many tropical vines.

Everywhere the writer worked, *Didelphis* was the most abundant opossum. That this is not always the case is evident from a statement by Goldman: "While this form may be said to be abundant, it occurs in smaller numbers at most localities than *Metachirops opossum fusco-griseus*." (1920, p. 46.) They were seen frequently at night by aid of a hunting lamp and were easily trapped. As many as four would be seen about the clearing in an evening, and as many as three adults have been observed feeding in a single tree. They are most numerous along wooded streams and in the forest, but many are seen along the roads running through the Cattle pastures of the Canal department of Cattle Industry as well as about houses in town.

Didelphis came to the clearing to feed on pineapple, guava, papaya, banana, and Star-apple, to all of which fruits it did considerable damage. Mangoes and figs are other foods. In captivity, they thrive on these fruits with the addition of the carcasses of rodents and flesh of any mammal, or birds and eggs, as well as insects. In the wild, they doubtless eat insects and everything small enough to overpower.

Crabs form a substantial portion of their diet, at least near seacoasts. (Goldman, 1920, p. 46.)

Females with two, five, and seven pouch young were taken in March, May, and August. Seven is the maximum number that can survive birth as there are but that many mammae. The young are practically indistinguishable from those of *D. virginiana*. A female captured March 4 had seven very small pouch young. It was April 14 before they came out of the pouch. Ten days later the young still entered the pouch to nurse and sleep, but it was not until April 27 that they were observed to eat, the food being figs. By this time they were large enough to hiss when handled and were very active, but returned to the mother from time to time. May 7, they were as large as some specimens that entered traps and were rather independent of the female although they slept in a cluster with her or near her.

There appears to be little understanding of the use of the tail, for opossums are mounted and drawn as hanging by this member, the extreme tip of which is wrapped tightly around a small twig. This the writer has never observed. A captive specimen showed remarkable strength when the tip encountered a strand of wire, but usually the grip of the tail around small twigs and vines is not very strong. However, the tail is invaluable to this Opossum as it is to *Marmosa* and many other prehensile-tailed mammals as a safety device. While treading its aerial highways, the tail is loosely curled around the limb or vine along which the animal is passing, and it can be clamped around a support with telling effect if the limb is shaken. Should the animal lose its footing the tail does much to prevent a fall. The "hands" of *Didelphis* make it very sure-footed on small vines, but less so on larger vines and limbs, and it is here that the tail is used most effectively. The writer has never seen this marsupial use the tail as a brace in sitting, or seen it assume the "tripod" attitude.

This mammal is a good swimmer: one individual when struck at dived under the water, swimming vigorously and rapidly.

Canal employees and natives alike rise up at the mention of the opossum to assure one of its deadly raids upon domestic poultry and on the game birds. The writer observed such a raid at Alhajuela. A medium-sized opossum took a month-old chick away from a hen at 5.30 A.M. The native to whom the chicken belonged said that the opossums were a source of constant loss. Nevertheless, he permitted the hens with chicks to spend the night under the floor of a shed in a situation which invited attack by all flesh-eaters, including rats of which there were many. The usual method of "housing" chickens

is to erect a few poles on uprights about six feet above the ground and trust that no opossums, owls, Tayra, or cats are hungry enough to eat them.

It is the writer's belief that these attacks are greatly exaggerated. If the members of this group are such blood-thirsty poultry- and bird-killers, why did a crippled "pavo" remain undisturbed on her nightly roost which was not more than eighteen inches above the ground when many *Didelphis* were seen about? She roosted unmolested from March 10 to July 3. True, there was much fruit available at this time, but the very type of poultry roost used rather discredits any great propensity for killing on the part of the rather stupid opossum.

The opossum makes a nuisance of itself about houses by climbing the vines usually grown to shade the screens, thus making considerable noise. It is probable that these excursions are made in search of insects that have been attracted by the lights or that have collected upon the screen. Trips are made to balsa flowers apparently to eat insects usually found there. Specimens were observed passing the day among the dry fronds of a palm and in dense growths of vines as well as in cavities under houses, so there is no lack of hiding places in towns. One individual built a nest of leaves on the lath roof of the greenhouse at Summit. Here it did considerable damage by eating seed, pulling up seedlings and tender plants.

Ticks are abundant on some individuals and nematodes are found in many. One individual carried a bot, *Dermatobia*, on the front leg. A large individual had furnished a meal for a Boa, as was discovered when the snake regurgitated it upon capture.

The pectoral gland, located under the yellow spot on the chest, secretes a yellowish, clear, fatty liquid which comes in contact with objects up which *Didelphis* climbs. The anal glands secrete a fatty, white solid which is thrown off when the animal is irritated. The secretions of the anal glands are much the more offensive to the nose.

ISTHMIAN MARMOSA

Marmosa isthmica

This opossum is the smallest marsupial found on the Island. The males are the size of a laboratory rat, while the females are very much smaller. Males average about 15 inches total length, of which the tail is 8; females, average total length — $12\frac{1}{2}$ inches, tail, 7. Large males weigh 954 mg., and females, 660 mg. On seeing a female of average size one appreciates the name sometimes given

to the group — Murine Opossums — for they are not much larger than some species of mice. The species may be distinguished from the rodents by the large mouth which can be opened widely, many teeth — the incisors small and pointed — naked ears, prehensile tail, and the feet with five distinct toes — the “thumb” on the hind foot being somewhat opposable. The general color is brownish cinnamon above, passing from ochraceous on the sides to cream buff on the belly. The large eyes are another distinguishing characteristic. There is no marsupium. The type was taken at Rio Indio, near Gatun, by Goldman.

Most of the *Marmosa* taken were captured alive, so little could be learned about their food by an analysis of stomach contents. Caged specimens eat a wide variety of foods including items they would not find in the forest. Thus raisins, cheese, bread and milk are favorite foods, although they thrive without them. Hudson's statement, made after observing specimens of *M. zeledoni* obtained from a fruit store in Lincoln, Nebraska, that “they lean strongly toward the insectivorous habit and capture live insects with great gusto” (1930, p. 159) is a good summary of their food habits. He states that they ate bananas, peaches, grapes, bat carcasses, viscera of mice and birds, and earth worms, as well as moths and grasshoppers. Caged specimens in Panama ate, in addition to the exotic foods listed, bananas, papaya, pineapple, star-apple, figs, mangoes, the curled tip of the espavé bean, and other soft fruits. Upon such a diet they would live for some time but finally would weaken and die. One night an individual was observed to climb down to the edge of the clearing, stalk a large green grasshopper, pounce upon the insect, kill it by crushing the head and thorax, then retreat to the cover of the tangle to devour its catch. All this was done under the glare of a powerful light which did not appear to disconcert the hunter. This episode resulted in experimentation with the caged animals. They caught and ate grasshoppers of all kinds, one female eating five large ones in half an hour late one afternoon. In passing, it may be observed that she retired to her nest to sleep and had not stirred out of it up to eleven o'clock that night. Nevertheless, she was ready for more next morning! The large grasshoppers are killed by a series of crushing bites about the head and thorax and only the harder parts and lower portions of the legs are discarded. It is an amusing sight to watch a tiny opossum sitting on its haunches eagerly devouring a large leg, strongly resembling a child with a “drum stick.”

One might suggest that since grasshoppers are not nocturnal,

Marmosa would not eat many of them under natural conditions. The writer is by no means familiar with insects, but has observed many large grasshoppers at night. Moreover, many of these insects are captured in traps set for Marmosa! So their ranges must meet somewhere. In addition to grasshoppers, stingless bees that were attracted to the cages by the discarded food were captured and eaten. When given a papaya stem that contained termites a female ate them by licking up those that had been exposed when a strip was pulled off. Unlike the anteaters, the White-face, or Titi Monkeys, she made no attempt to pull apart the stem to uncover other termites. This is to be expected, for Marmosa is small and weak.

After the introduction of insects into the diet, the animals remained in much better condition. Cheese made a good substitute for insects. Salted nuts were always accepted, the salt licked off and the nuts discarded. The craving for salt may have been the result of too much fruit in the diet, for these were captive animals. While no offal from mice was eaten, animals that died were partially eaten if not removed at once. It is possible that one death was the result of an attack by a cage mate; whether or not the object was to eat the victim, the fact remains that it was partially eaten. Kraatz (1930, p. 288) reports finding parts of two young eaten, probably by the captive mother. Insects are preferred to flesh, but it is probable that under certain conditions of food or confinement flesh is eaten. All of the figs on the Island are badly infested with larvae of various insects. Marmosa is partial to very ripe figs, eating the inner pulp, seeds, larvae and all.

Like the other opossums, Marmosa is a solitary animal. More than one adult was never observed occupying the same nest, nor were they observed hunting together. When in captivity they lived together peaceably, as many as five occupying the same nest cavity. Weak ones were attacked however, and partially eaten. They will fight furiously over food placed in the cage unless it is so divided that each can carry a portion to a corner to eat alone. Even then fights may occur if the weight of the food is not great enough to require all their strength to carry it. Two females removed from traps and placed together sprang at each other at once. However, they usually live together peaceably, even though several adult males and females are placed together.

In spite of the small size and feeble dentition of the animal, Marmosa is a ready fighter. Two females that had been kept together for several weeks were peaceable until food was placed in the cage. On one occasion, two grasshoppers were presented to them. The first

one to receive a grasshopper grasped it in her forepaws, promptly bit it through the back of the head, took it in her left paw, and immediately started after the other grasshopper which had been, in the meantime, captured by her cage mate. She did not seem to be noticeably handicapped in her attack by the fact that she was running on three legs with the grasshopper clutched in the fourth. The other *Marmosa* upon being thus approached instantly assumed the fighting posture. Grasshopper firmly held between her teeth, head up, forepaws raised in striking position, and balancing herself on her hind legs with the tail as a brace, she met the onslaught. In the ensuing melee both grasshoppers were forgotten as the *Marmosa* took up the fight in earnest, rolling around on the bottom of the cage, biting and hissing. It was with great difficulty that they were separated, and both showed an eager willingness to resume the combat, for when one was picked up by the tail, instead of turning to bite the hand, she devoted all her attention to holding her opponent, finally lifting her off the floor by the strength of the grip of one front paw on the fur of the rump of the other female. They had to be placed in individual cages for their safety.

The adults are no more aggressive nor willing to stage an active difference than the young. Two half-grown *Marmosa* were placed in a cage with a Spiny Rat, where they settled down in one corner taking no notice of the other inmate. However, when food was placed in the cage and the octodont approached the feeding *Marmosa*, one of them sprang at the intruder with open mouth, hissing venomously. The attack was directed at the head and with such speed that it could not be determined whether the rat was actually bitten or merely struck, but it was sufficiently effective to drive back the aggressor and keep him at a distance, despite the fact that he was many times the size of the half-grown *Marmosa*.

The same remarkable courage is shown whenever *Marmosa* is approached. How effective this method of defense is cannot be determined, but it is certain that it is not mere bluff, for most individuals will bite if pressed. After assuming this defensive posture they will sneak off if not further molested. At no time was a *Marmosa* observed "playing 'possum," nor could individuals be induced to do so, always showing instead remarkable ferocity for an animal so small. *Marmosa* is no more intelligent than the other opossums.

Marmosa hole up where daylight overtakes them. In an attempt to study the nesting habits of certain birds, a large number of bird boxes were put up around the edge of the clearing and through the

forest. These boxes were made of a cylinder of roofing paper capped, top and bottom, with metal, and suspended by means of wire. One day Donato drew attention to the presence of a *Marmosa* in one of these nest boxes; after this experience these boxes were examined regularly, and others, more suited to *Marmosa*, were placed in the plantation. Thus an opportunity to study the nesting habits was offered.

One nest box in particular appeared to be a favorite. It hung about seven feet above the ground in a small tree, one of a dense stand a few feet from the edge of the clearing. When first observed, the box contained a nest of dry leaves and was occupied by a young female. It was twenty-five days before she was seen again in this nest. In the interim, no less than three individuals used the same box. Each individual first dragged in some dry leaves to form a nest, for whenever the box had been found unoccupied, the leaves were removed. None of the "visitors" stayed long. The daily observations may have disturbed them even though they were made with as little commotion as possible. In another box some fifty yards away where observations were made irregularly and the nesting material left undisturbed, the same transient occupation was observed. In none of the boxes located in deep forest were signs of use by *Marmosa* discovered.

Abandoned bird nests are used in the same manner by *Marmosa*. One specimen was taken from the nest of a Mexican banana quit (*Coereba mexicana mexicana*), and feces of *Marmosa* were found in several nests including that of a mannikin. These nests were occupied irregularly as were the nest boxes. Although they are reported in cavities and hollows in the forest, no such nests were found that could be assigned without qualification to *Marmosa*.

In banana plantations there are many nesting sites. The young curled leaves, the bases of mature leaves both living and dead, as well as the cavities under the hands of the developing bananas all offer excellent sites for nests. Strips of dry banana leaves are carried into such nesting places as may be seen upon examining the trees and stems. It is this habit that accounts, at least in part, for the animals that reach this country as stowaways on the banana ships.

In sleeping, the typical rodent position may be assumed, or the animal may lie curled up on its side. If in an exposed position, the animal crawls under the litter to sleep; in cans or nest boxes, it curls up on the nesting material. Like the other opossums, *Marmosa* is a deep sleeper, allowing a very close approach and sometimes con-

siderable disturbance of the cage before awakening. If the animal does not see the cause of the disturbance, it may either cower where it is or attempt to sneak off, but if a hand is nearby, the defensive attitude is assumed at once.

No one can estimate the home range of the animal. Because it is a slow mover, whether on the ground or among the tangle, which is preferred, any great individual range would not be expected. However, clearings and "blow downs" are some distance apart, but all that were consistently examined showed the presence of the opossum. A shifting food supply must force individuals to wander considerable distances. The day is spent in any suitable spot where daylight overtakes them; there appears to be no fixed abode. This would aid them in covering considerable territory, even though the rambles of one night would not take one far from the resting place of the previous day. Movements that cannot be accomplished by speed can thus be achieved by persistence and mobility of domicile. Two individuals, both adult males, were captured about four hundred yards away from suitable cover.

During the first trip made by the writer, several types of traps were employed to capture animals. Specimens were taken in rat traps, Schuyler traps, spring-floor rat traps, and homemade live traps that were set on stumps, on vines, and on and under logs, and on the innumerable trails through the dense growth. Naturally, many other mammals were taken in addition to *Marmosa*. The live traps were most effective, so on the next trip only spring-floor rat traps and a dozen small Sherman traps were used. The spring-floor traps were set as they were the first year, while the Sherman traps were tied to small vines, branches and so on. One of the most striking demonstrations of the great difference in weight between the two sexes was encountered here, for it was possible to set a spring-floor trap "hard" enough to catch males only, or animals of similar weight, while females or immature males and mice were the only specimens small enough to enter the Sherman trap. Thus, if bait was eaten out of a spring-floor, a Sherman trap was introduced into it, the "hardness" of the set was increased, and the trapper was usually rewarded by the capture of a female. Similarly, if a Sherman trap, located out of the reach of *Didelphis* or *Coati*, had been disturbed, a spring-floor trap would usually capture a male. This is not to be interpreted to signify that the females cannot be taken in the spring-floor trap, but that, for practical convenience in setting, the spring-floor was coarsely adjusted to the weight of a heavier animal. The third season again

demonstrated the superiority of live traps that could be tied to vines and branches. In fact very little use was made of any other style.

The most productive bait was the universally liked banana. Papaya and mango were also excellent. The usual rolled oats, and combination of rolled oats, raisins, peanut butter, and bacon fat were tried but attracted nothing save ants. Nuts were no better except that ants do not disturb them, nor do they sour in the damp warm atmosphere. Live grasshoppers tied in the traps by passing thread around the thorax were tried but they were not effective. Bait is not necessary when using Schuyler or rat traps placed on logs or trails as the animal is not wary and steps on anything in its way.

The enemies of *Marmosa* must be legion, for it is small and although valiant in defense, it is relatively weak. For safety, it must depend upon the dense tangle through which it moves slowly but securely, for a heavier animal cannot follow on the slender, flexible vines, nor can an enemy in the air attack it under such circumstances. The only hawk likely to prey upon this little opossum is the White-throated Bat Falcon which was seen hunting over the clearing many times, but no evidence of any kind was secured to indicate that it did secure any individuals. The falcon is, however, large and strong enough to feed upon *Marmosa*. Several of the owls might be listed as possible enemies, but the animals do not appear to fear attack from the air for about the plantation, *Marmosa* traveled along the tops of banana leaves in a manner that exposed it to any attack from the air. Progress under these conditions was very slow and quite noisy.

Tate (1933, p. 126) quoting a communication from G. M. Allen says: "Fragments of jaws referable to this species and others, apparently of *Philander*, have been discovered in the casts of the owl *Pulsatrix* on Barro Colorado Island in Gatun Lake, Canal Zone."

Any carnivore or omnivore large enough to overcome *Marmosa* must be listed as an enemy. *Didelphis* is included here, for one individual broke into a cage containing a *Marmosa* where it was found next morning along with the remains of the original occupant. Coati visited the cages where specimens were kept and were seen attempting to enter some of them. One Coati succeeded in opening a cage, so the cages were moved into an enclosure. Coati were seen attempting to secure *Marmosa* captured in live traps, and many of the live traps broken into showed the marks of Coati. Coati, therefore, is listed as a great enemy, possibly the worst.

While traveling along the small trails, or over the ground in the plantation, *Marmosa* must be exposed to many hazards. As the

small trails traversing the shrubby thickets are used by many mammals, some much larger than *Marmosa*, it would be surprising if some did not meet their fate in this manner. In one pellet of *Ocelot* dung was found hair that may have been that of *Marmosa*.

Many individuals taken were infested with *Porocephalus* sp., according to E. W. Price of the Bureau of Animal Industry who kindly identified them. These are immature, and occur in the mesentery, under the diaphragm, and in the liver and lungs, as well as in the abdominal and thoracic cavities. One specimen died two days after capture; the liver and lungs were heavily infested and the arch of the diaphragm inclosed many. This was the heaviest infestation noted. No individual examined was suffering from bot-fly infestation.

Marmosa can be said to be strictly nocturnal not crepuscular. They begin their nightly search for food after dark. Specimens were never seen nor removed from traps before 7.00 P. M., nor do they appear to be at large toward the end of the night. This statement is based upon the fact that *Marmosa* were generally removed from the traps on the round made from seven to eight, and those caught in snap traps not visited were badly decomposed by morning. By 8.30, many of them are moving about, hungry cage specimens becoming active even before this hour. On the other hand, during rainy weather specimens were found in the nest boxes still resting at this hour. The greatest activity of *Marmosa* in the plantation appears to take place during moonlight nights. Most of the specimens observed under these conditions were males. Well fed animals do not come out until much later and retire again as soon as they have eaten. However, they are not so strictly nocturnal but that they will eat during the daytime if hungry or particularly choice food is offered. Apparently they suffer considerably when exposed to a bright light for their eyes water, a film may appear over them, and the animal assumes a general attitude of dejection.

Marmosa is most at home among the small trees and vines to which its feet are so well adapted. Its most rapid progress is made along vines or branches up to half an inch in diameter. These it grasps readily, using the semi-opposable thumb of the hind foot with great effect. Except when climbing perpendicularly, the tail is always carried curved loosely around the limb. When an intersecting branch or vine is encountered, the tail is uncurled in order to go by it, but immediately encircles the support when the obstacle has been passed. Thus the tail while useful as a safety device does not play an important role in locomotion. However following etherization, control of

the tail is regained before the use of the limbs, the animal being able to hang by its tail before it is able to hold on with all four feet. On the ground *Marmosa* moves as do the other opossums, and can be hurried into a gallop if pressed. None of its motions are very rapid and it is very easily overtaken.

When *Marmosa* reaches a gap it may attempt to leap across it; the distance covered by such a leap depends largely on the position from which the animal makes the leap, as well as the type of footing afforded. Thus, in passing from one banana tree to another, the longest leap observed was approximately seven inches. Considering the flexibility and smoothness of the tip of a banana leaf, this is more difficult than a much longer leap from more secure footing. In making such a leap the animal sails through the air with legs outstretched. One female hanging perpendicularly to a small, smooth-barked tree attempted to leap to another which was seventeen inches away. Although she reached it, she missed her hold as she had not jumped far enough. This might have been due to her hurry in attempting to escape, to the bright light, or to the smoothness of the bark which offered a very poor footing. The longest jumps are made from a place where they can assume their typical jumping position. The tail is placed straight behind and used as a brace, the hind legs placed well apart, resting upon the entire foot up to the crus, the front feet are placed between the hind legs, the back is arched. First, the front feet are raised with the anterior portion of the body, and then the back is straightened with the hind legs supplying much of the impulse to carry the body forward. In moving through the tangle, no leaps were measured, but it was observed that if the front feet reached the objective the animal was able to clamber onto it. If at this crucial point, the perch is shaken, it is grasped with the teeth as well as the forepaws until the hind feet and tail can secure a purchase.

Of all the natives to whom live *Marmosa* were shown, only four or five recognized them as having been seen before and only two recognized them as opossums. No native name was applied to the specimen excepting the very general term "raton" or rat. From this one might infer that it is a rare animal. This is not the case for it is abundant. Being nocturnal, a shy and inoffensive creature, and of no use as food nor a threat to man's poultry or produce, it is not hunted. Those unfortunates that are discovered in clearing brush, or cutting bananas are killed at once as rats for which they are mistaken.

However, men who work on the barges buying bananas along the shores of Gatun Lake, say the "banana rats" are common at times. As they fail to distinguish between *Marmosa* and rats, as well as two other genera of marsupials, it is doubtful whether their estimates are accurate. Mr. W. H. Babbitt, who has had a great deal of experience in Panama, assures me that he has seen as many as six in one barge load of bananas. This is accurate for Mr. Babbitt was familiar with the species and its habits. In fact, he was the only person who was able to trap any specimens. All who are familiar with *Marmosa* refer to this apparent abundance at times and its rarity at others.

This checks with the experience on Barro Colorado Island, at Summit, and Alhajuela. Thus *Marmosa* was so frequently trapped during June and July, 1929, that it was considered to be one of the two most abundant mammals on the Island. During this period eight were captured. As no special pains were taken to secure this species the number was more indicative of the general population than later figures when *Marmosa* was the chief object of an intensive search. More than forty were taken between November 13, 1930, and February 18, 1931—twenty-four being trapped alive during the first two weeks of February! Six were captured between February 28 and March 8, 1932, but no more until April 6 when a single male was captured, then another on May 19. No more were seen before leaving July 2, nor were any secured from the banana buyers who had been interested in the middle of June.

What factors operate to explain these changes? Are they changes in population, or just a shift in range? There are four possible explanations. The species may have been:

1. Trapped to the point of extinction
2. Reduced by an epizootic or by parasites
3. Changed habitat with the breeding season
4. Changed food and feeding grounds

That they were not trapped to the point of extinction is clearly indicated by results of the trapping in February, 1931, when trapping was discontinued while the animals were abundant, coupled with the fact that when trapping was resumed in February, 1932, many were taken during the first week or so. Moreover, even though they did not enter the traps some individuals were observed.

Although *Marmosa* suffers from some ecto-parasites and endo-parasites to the extent that some die of the infestation, neither parasites nor an epizootic would explain the sudden absence from traps

without the discovery of at least one or two very much weakened or dead animals.

There is a possibility that there is a change in habit with the breeding season for none of the females taken were pregnant. Moreover, the *Marmosa* reported from the United States, which they reached as stowaways in bunches of bananas, are mostly females with young. Later a discussion of this will be given. It is mentioned here to indicate that, possibly, pregnant females retire to cavities, hollow trees, and so forth, until the young are born. This would not account for the change affecting the males.

The change in food and feeding grounds appears to be the real explanation of the apparent fluctuation in numbers. Toward the end of the dry season succulent foods and fruits are scarce in the forest and many of the insects upon which *Marmosa* feeds decrease in numbers. This concentrates the animals along the clearings where the grasshoppers abound and where there are discarded papaya and bunches of bananas upon which to feed. At the same time the scarcity of food leads them to enter traps baited with the fruit they cannot secure in the forest. During such a period, eighteen were caught in four days. With the ending of the dry season many fruits ripen and the bait offered is no attraction. Hence few specimens can be captured until with the advancing rainy season, another period of scarcity arrives, and the hungry animals again enter the traps.

Considering the fact that most of these animals were taken about a clearing but a few acres in area, the writer is convinced that *Marmosa* is a common mammal in suitable habitats on Barro Colorado Island, even though an accurate means of estimating its numbers is not at hand.

By far the largest numbers were found in the intricate interlacing of vine and branch that characterizes the second growth which abounds around the edges of clearings. Here are the pathways to which the feet of *Marmosa* are so well adapted. Here the growth is so dense that large enemies can be eluded; here abound many of the insects that form the important part of the food supply; and here is afforded a base for sallies into the clearing. Traps placed on small trees, stumps, branches and vines captured many specimens and many were observed hunting for grasshoppers and katydids along the edge of the tangle and on the ground.

Marmosa is not an animal of the deep tropical forest as much as a dweller along the edges of clearings, in plantations where cultivation

is not too clean, and in "blow downs." Few individuals were seen or trapped more than twenty feet above the ground; those that were seen were only in the deeper forest. Indeed, their feet are not too well adapted to climbing large trees nor are they able to move rapidly along large limbs. Their method of locomotion and feeding habits are much better fitted to second growth forest, lower tangles, and banana plantations.

One might ask where such an animal found this type of habitat in the original forest. Many of the trees are shallow rooted and are bound to each other by strong lianas and vines. The accumulation of weight must place a serious strain on the roots. When the soil is softened by rains, an extra strain put on the roots by the pressure exerted by high winds, or through the weakening of a tree by decay, widespread destruction may occur. In such circumstances a tree does not fall alone but carries with it many neighbors. Thus the destruction may spread over an acre or even more. Here among the tangle of trunks, branches and vines is an ideal hunting ground for the small opossums. It is in such places in the forest where *Marmosa* were taken.

Plantations, chiefly banana plantations, offer another environment where *Marmosa* occur. They were found living in banana trees, as one would suspect from their frequent occurrence in bunches of bananas. Bananas are planted some distance apart so that, as a rule, *Marmosa* must descend to the ground to pass from tree to tree. Where the plants were close enough together, individuals were observed passing from one to the other by dropping from a higher leaf to a lower leaf on the neighboring tree. *Marmosa* occupy other types of plantations such as papaya, citrus, and mango. While by no means an ideal habitat for *Marmosa*, numbers of them are found in plantations.

Every year there are several reports of *Marmosa* of various species being imported in stems of bananas (Shanafelt, 1927; Preble, 1926; Kraatz, 1930; Potter, 1930; Warren, 1928; Wagner, 1928; Adams, 1928; Enders, 1930; Hudson, 1932). When, in its natural haunts, a ripening stalk of bananas has been selected as a retreat, the story is not difficult to reconstruct. When the cutter comes along he cuts the tree so that the stalk is gently lowered and the bunch of bananas is grasped by the carrier before the final cut severing the stalk is made. This would disturb, but might not alarm, an animal within. Doubtless, many flee at this point or escape while the stalks are in the banana barge or on the train. Once delivered into the hold of a ship there

would be little likelihood of finding any better hiding place. The bananas are quite green when placed in the hold and are, therefore, unfit for food for *Marmosa*. Among the stalks and packing are numbers of insects of many kinds — spiders, tarantulas, roaches, and others. The problem of food may be solved by eating insects. Some ships refrigerate their holds and others do not. Aside from the matter of temperature, the conditions in the holds are very similar. Because ripening bananas consume much oxygen, a constant stream of fresh air is forced into the hold. In either case the stream of air enters unchilled, so conditions near the entrance are approximately the same.

The holds of refrigerated ships are held at temperatures ranging from 57° to 52°. It has been suggested (Wade, 1930, p. 365-366) that 57° "approaches very closely the ideal hibernating temperature of mammals exhibiting this phenomenon," and as the capacity for temperature regulation is imperfect for certain of the lower mammals, he asks, "Might it not be possible that these small opossums of the genus *Marmosa*, kept in a subnormal temperature, were unable to maintain their body temperature and became lethargic or partially so with the consequent reduction of metabolic activities? Under such conditions no food taking would occur and with the metabolic rate greatly lowered the animals could survive extended periods of adversity. This would be still more plausible for the immature individuals as the young of many mammals do not have the regulation of body temperature well established at first."

Wade wrote this after reading a paper (Enders, 1930, p. 438-439) in which the writer speculated concerning the food of the animals while in transit. Since publishing the above note the writer has learned more about the food habits of the opossum as well as the conditions existing on banana ships.

In refrigerated ships, while the temperature of the hold may be held as low as 52° F, a constant stream of air is forced into it. This air is not pre-cooled, but passes into the hold directly from the intakes on the upper deck, thus being, at least for many months of the year, warmer than the air in the hold. To this incoming flood of fresh, warm air come many of the insects that were sealed in the hold with the bananas. This concentration of insects is so great that it is recognized by the engineers in charge of refrigeration and is usually explained by stating that the concentration of carbon dioxide in the hold is so great that they would die if they did not seek the incoming, oxygen-bearing air stream. Regardless of the explanation offered, the engineers agree on the fact of concentration.

Such a condition is ideal for *Marmosa*. It is a nocturnal animal with a well developed ability for securing insects at night, and is highly insectivorous. Moreover, it too, would seek the warmer portion of the hold and thus come in contact with the insects instead of being compelled to hunt them among the cargo. It is easy to picture the events in such a case. When the hold was opened the *Marmosa* would retire to a stalk of bananas and the handling experienced in Central America would be repeated.

Examination of the reports of *Marmosa* stowaways reveals the fact that the majority are females with young. How can this be explained? In the first place males are much larger, so might be discovered before the stalk was transported very far. However, larger genera of marsupials including *Metachirus*, have been reported. Males might, too, be more inclined to leave a hiding place when disturbed than would a pregnant female, or a female with newborn young. Nor must one overlook the fact that the "banana rat" would be killed and tossed aside with but little interest unless young were found with her. As has been said elsewhere, it is very possible the pregnant females seek out some retreat and stay in it or very nearby until the young are large enough to venture out with her. Stalks of bananas would serve very well for a nursery which would explain the preponderance of females with young.

It was chiefly with reproduction in *Marmosa* that the writer was concerned during two visits to Panama, but very little was learned. In the first place, there were only two records of young individuals that could be definitely assigned to the Canal Zone species. The difficulties of identification of species and port of origin made the records from stowaways of doubtful value. During one summer the writer had taken juveniles and lactating females. It was thought that in the absence of breeding records of the tropical opossums, breeding might take place at any season, as appears to be true of *Didelphis marsupialis*. So trapping was inaugurated in November. Thus from November 13 to February 19 more than forty were taken; from June 24 to August 3 of another year, ten; and from February 24 to April 6, eight were captured. Not one female was pregnant! Histological sections of many ovaries disclose nothing but the dioestrus condition. Juveniles were trapped on May 19, June 24 and July 12, and a sub-adult, August 3. All of the others were adult. Of these, one taken July 12 was lactating.

Among the records of banana stowaways, not all of them satisfactorily determined as to species, young are reported in March

(Enders, 1930, p. 483), June 14 (Kraatz, 1930, p. 288), and August (Warren, 1928, p. 422). From the last report one would judge that the young were about ready to assume an independent existence. These dates check with the experience of the writer in the field, and lead to the conclusion that *Marmosa* breeds but once a year, probably in late February and March. It follows that the young born one spring do not breed until the next year for which conclusion there is much support to be derived from the histological study of the reproductive systems of many females.

There is some variation in the number of mammae. Bresslau's table states that there are from nine to fifteen in *M. murina*; nine to eleven in *M. cinerea*; while the writer found that in *M. isthmica* the number was usually thirteen. The mammary area is approximately 2 cm. wide and 3 cm. long, six mammae being arranged in something of an arc on each side with one in the middle of the area. Hence regardless of the number of young born, only thirteen could secure attachment and thus survive. How many are born is not known, but within the genus, the number of young reported runs from "nearly a dozen" (Kraatz, 1930, p. 288) to ten (Hill and Frazer, 1929, p. 191), nine (Potter, 1930, p. 91), six (Shanafelt, 1927, p. 103) (Hudson, 1932, p. 159); on down to one (Warren, 1928, p. 422). In the field the single female with young had two young, but as they were large enough to be independent of her the others may have left her when she was trapped.

No reports of young at birth or shortly after birth are on record. Judging from other marsupials of the same family, it is supposed that they are born after a short gestation, are small, naked, helpless, and that they seek the mammae and become attached as do the young of marsupials having pouches. The smallest young observed by the writer had a body length of approximately 22 mm. They were firmly attached to the mammae, or so it appeared, fully covered with hair which differed from the adult condition only in being darker and softer; the eyelids were incompletely formed as was the mouth. Nevertheless, the mother freed herself from them, leaving them in the nest when she went foraging. This same habit of leaving the young in a nest while the mother hunted may explain a case encountered during field work. A lactating female was captured in a live trap and two quarter grown young taken thirty-six hours later. When placed together, the young clung to the female and she was very active in defending them. Moreover, she permitted them to take food away from her, an action difficult to explain on any basis

other than that she was their mother. The young may cling to the female after she has been killed, Hudson (1932, p. 159) reporting the finding of a recently killed female that "had six living young attached to her mammae and fur."

"Daubenton . . . gives a short account of the genital organs of another Didelphyd under the name of 'la Marmose', which Mr. Hinton has been good enough to determine for us as *Marmosa murina*. The female had ten attached pouch-young, four lines in length, four vacant nipples, and no pouch, though two slight lateral folds bounded the mammary area." (Hill and Frazer, 1925, pp. 190-191.) In *M. isthmica*, as has been said before, there are but thirteen mammae, and no indication of folds bounding the mammary area has been found even by a study of the abdominal musculature. This illustration is of importance, in spite of the rather unnatural pose of the female, in showing the method of attachment of the young.

Many more observations of young that have passed the stage where they cling to the mammae are on record. "Nearly a dozen young were clinging to the mother . . . The young clung with claws almost anywhere on the fur, but principally ventrally, and occasionally on the tail. A few times one of the young wandered off a few inches. When I approached it closely, the mother would grasp it with the claws of one foot and speedily thrust it under her," says Kraatz (1930, p. 288), speaking of *Marmosa* — either *isthmica* or *zeledoni*. Potter (1930, p. 91) in speaking of the genus says: "All nine are carried on the back and sides of the mother. They cling to the fur with their mouths and feet and occasionally are aided by the prehensile tail. The mother was seen to toss the young from the floor to her back with her nose, and the young grasp the fur on her back upon alighting."

Still later in development the young, when disturbed, grasp the fur of the female with tooth and claw. At this stage they are about three-fifths grown and are able to survive independently.

The statement is made frequently that the young become attached to the mammae from which, without effort on their part, milk is "pumped" into their mouths by the action of the muscle of the mammary gland. This action is variously ascribed to the cremaster "ilio-marsupialis" or panniculus carnosus. In passing, it may be said that such an action is more than problematical and the matter will be taken up in a paper on the ventral musculature of the Didelphid marsupials.

ALLEN'S OPOSSUM

Metachirops opossum fuscogriscus

This opossum is of medium size, the pelage short with no bristles projecting through the fur which is unlike the long woolly pelage so characteristic of the phylander. In size it is similar to the Brown Opossum but differs from it in its general grayish coloration, the eye spots being very light.

No specimens of this species were taken on the Island but one was observed high up on a limb on Zetek Trail under the rays of a hunting lamp. They are not common on the Island for while they enter traps without hesitation none were taken; but many were captured at Alhajucla in habitats similar to those on the Island, and J. B. Shropshire's men sent the writer numbers of them from the Zone. Why they are not abundant on the Island is a puzzle.

Next to the Brown Opossum, this is the fiercest fighter of the opossums studied. Allen's Opossum is ready to fight at all times and no amount of handling appears to diminish its resentment. Goldman (1920, p. 52) found that they fought savagely when taken in steel traps; to this the writer can add that they fight the same way whenever touched. However, they are a bit more tractable than the Brown Opossum.

These opossums, too, are accused of being poultry- and bird-killers, and Goldman's observations bear out this fact. In captivity they were more carnivorous than any of the other opossums observed. They ate meat of all kinds including ant-eater, carcasses of rodents, grasshoppers, and eggs in preference to any kind of fruit, although they did eat banana, papaya, pineapple, and figs. One hungry individual, while fearful of the hand offering a ripe banana, nevertheless sniffed from a safe distance while saliva dripped from its jaws.

Goldman (1920, p. 52) says of this opossum's nesting habits: "A nest of one of these opossums was found three feet from the ground on a fallen log. The log lay in the dense thicket of an old clearing and was heavily overhung with vines and bushes. The nest, globular in form and about a foot in diameter, was placed in a well-hidden spot among the vines. It was made entirely of the banana-like leaves of a native plant rather neatly laid together. The opening at one end faced outward along the log. The occupant slipped quietly out of the nest, when I was within three feet, ran rapidly along the log and disappeared in the thick vegetation. The nest cavity was

clean and about the size of the animal's body." In captivity they lined the nest boxes with dry banana leaves furnished for the purpose.

While a good climber, *Metachirops* was usually encountered upon the ground, on or under logs. It is probably more terrestrial in habit than any of the other opossums studied excepting possibly *Didelphis*. This might be surmised from its build, which is well adapted to terrestrial locomotion.

Five is the largest number possible in a litter that can survive, as there are but five mammae. The mammae are located two on each side and one in the middle. The pouch is not as well developed as in *Didelphis*. Non-breeding females were taken from January to April. After that date until July, females with litters outnumber the others; litters of two, four, and five were observed. As pointed out by Goldman (1920, p. 52), the young do not seem to cling as closely to the teats as similar young of *Didelphis*. Although only comparison at birth would establish the fact, apparently they are more mature at a given age than *Didelphis*.

The type of this species was discovered in a bunch of bananas in unloading a steamer from a Central American port (Allen, 1900, p. 194)

BROWN OPOSSUM

Metachirus nudicaudatus dentaneus

Although the Brown Opossum has been seen several times on the Island, it has never been taken. Thus, Dr. Barbour and Dr. Chapman saw one climb a balsa tree and go to a flower, and Dr. A. Skutch saw one in a tree by the tower. The numbers sent to the Island by Mr. Shropshire's men were considerably less than Allen's Opossum. However, several were seen near Las Cascades hunting at night.

The outstanding characteristic of this medium-sized opossum is its savageness. In attitude as well as disposition it reminds an observer of a weasel more than an opossum, for it is fast and aggressive. Without doubt, it is the most difficult opossum the writer has tried to handle, for it is strong, and wriggles and squirms until a finger or thumb is within reach, and then bites with telling effect. After making a few attempts bare-handed, a heavy glove covered with chain mail was used and although the teeth could not penetrate, the strength of the jaws was a constant source of surprise.

Bates (1888, p. 231) says that an opossum with soft brown fur not as large as a rat, was caught in a fowl-house. He may have

referred to a relative of this species. "The terrestrial species," he says, "are nocturnal in their habits, sleeping during the day in hollow trees, and coming forth at night to prey on birds in their roosting places." While the Brown Opossum is strong and fierce enough to prey upon birds of considerable size, the captive specimens were not as carnivorous as *Didelphis* or Allen's Opossum, preferring fruit to fresh meat or carrion, and thriving on it. No live animals were offered. It is significant that one was shot while feasting in a mango tree.

Litters of one and three were observed though there are five mammae. The pouch is much as in *Metachirops*. One female with a single young was received December 18, and placed in a cage where they were kept under observation until the following March. The young one, a male, was about two inches long and was able to stand alone, being more independent than a *Didelphis* of comparable size, but, like *Didelphis*, the control over the forelimbs was better than over the hind. He reacted with searching movements when touched, and when placed by his mother, he grasped her at once, seizing her over the hip, and making wide, sweeping motions with the head and anterior half of the body as though looking for a nipple. The mouth was fully formed, as were the eyelids; the hair was beginning to grow. In ten days he was fully haired with the same pattern as the adult, but both the brown and white portions of the pattern were duller. While he now spent much time out of the pouch, he clung to the female at all times, riding her back or hips. Although still nursing on January 8, he was seen away from the female for the first time. A month later and he was fully independent of her, so they were separated.

In addition to the cranial and color differences between the two genera, *Metachirops* and *Metachirus*, there are many others that are equally distinctive. Thus the eyes of the first show up as a reddish yellow under the hunting lamp while the eyes of the latter show red. The eyes of the young of both species show yellow. The difference in food habits has been referred to above as has that of disposition. *Metachirops* used the "tripod posture" more frequently than *Metachirus*, although the tail of the latter is a very effective appendage. One individual was shipped to the laboratory in the same box with *M. o. fuscogriseus* of approximately the same size. It had been thoroughly cowed by the more aggressive *Metachirus* and showed signs of having been bitten severely about the head and neck, while the aggressor was scathless.

WATER OPOSSUM .

Chironectes panamensis

It is doubtful if this opossum occurs on Barro Colorado Island, for there are no streams that carry enough water the year around to meet its requirements. The following account of the animal is given by Zetek (1930, pp. 470-471):

"The only common name for this animal obtainable was 'Gato de agua,' a name used for nearly every mammal that frequents streams. Beebe calls it 'Yapock'"—a book name presumably derived from British Guiana. "The stream at Fort Sherman has running water and innumerable pools in its bed, of various depths. The bank was about four feet high. Shropshire's specimen was found about mid forenoon asleep on the ground above the bank and close to it. It had a very definite nest measuring about six inches in diameter made of leaves of various sorts.

As soon as the animal was disturbed it jumped into the water and dove, coming up shortly on the opposite bank and entering a hole about four inches in diameter, just above the level of the water in the stream. Upon exploration, it was found that the cavity was about two feet deep, somewhat enlarged at the end, and its direction downward at an angle of about forty-five degrees. It contained remnants of crustaceans and the part below the stream level was filled with water.

In the laboratory the opossum slept during the daytime, covering itself with whatever was placed in the cage. During the night it was very active. It ate shrimps freely, though dead ones only were placed in its cage. Attempts to photograph it during the first few days met with failure. It would never remain very quiet, trying to escape, and invariably kept opening and snapping its jaws. It would also hump up as if to jump, and when in this attitude the tail appeared to be very much longer than it really was.

After the fourth day it would allow itself to be handled and was much more quiet when photographed. Even so, it was not possible to use the camera shutter because the animal would move the instant the shutter clicked. Instead, a lense cap had to be used.

The specimen measured 20.5 inches from tip of nose to tip of tail; the tail was 12 inches long, of which the extreme two inches were almost pure white in color. The underparts, inner faces of the thighs, and the upper parts of the hind feet are white."

To the foregoing can be added the observations made on two specimens kept first in the laboratory, then in a large outside cage. The first specimen, a young male, was placed in a cage in the laboratory and given a quantity of grass. Into this he bored at once shaping a nest cavity by turning around and around. Whenever he was removed and fresh nesting material placed in the cage, he made a nest immediately. When transferred to the outdoor cage, a nest of dry leaves and trash was made at the base of a small clump of hat palms. Here he spent the day curled up tightly and was not easily disturbed. No tendency to burrow was observed in either specimen.

Since there were no shrimp available, the young specimen was given beef. He began to eat at 7:45 P.M. chewing the meat with considerable noise. Pieces were chewed off, using the back teeth as sectorials and then, even though the chunks thus cut off were large enough to cause straining, were swallowed whole. During this process the animal sat on its haunches using a somewhat tripod posture and holding the meat in its forepaws with a skill much greater than that displayed by any other marsupial observed. Next day cooked crayfish was fed and again the animal sat on its haunches, manipulating the food with the forepaws. While he was eating, a seventy-five watt lamp was turned on within six feet of him without disturbing him. Carapace, antennae, and mouth parts were all eaten excepting the hardest portions. The jaws are powerful, the face appearing to be short because of the massive muscles of mastication.

Later, live crayfish were placed in the cage with the immature *Chironectes*. Although the body of one crayfish was as long as that of the opossum, he attacked and killed the crustacean. The attack was directed at the head which was reached by approaching from behind and parallel to the body of the crayfish. The strong jaws were used very effectively in crushing the anterior portion of the carapace.

Although *Chironectes* can climb, it is done unwillingly. Both specimens found little difficulty in running up the hardware cloth of which the cage was made. When placed on a branch, they used the tail either by placing it about the support or by holding it out stiffly thus using it as a balancing organ. This is quite in contrast to its use by other marsupials of the region. While prehensile and similar to that of *Metachirops*, it is too thick for effective use in climbing. On a hard rough surface there is a marked tendency to pull out the nails of the forefeet. Swimming was observed in a small pool of the outdoor cage. The use of the forefeet was not determined;

the hind feet were used alternately, the tail streaming out behind. Change of direction was apparently made by using the front feet and changing the body position. The broadly webbed feet are strong and effective propellers. The stroke is made along the median line so the hip region does not swing from side to side.

The eyes of *Chironectes* are very black and lustrous; the tail much stouter than in other *Didelphids*.

To the writer, one of the many amazing things about this unique mammal is the presence of a well-developed pouch in the male. The hunter who sent in the specimen to the laboratory insisted that it was a female and casual observation of the animal when it was disturbed and active led others to the same conclusion. But closer examination revealed that the scrotum was pulled into the pouch. Anatomical details of the structure of the pouch and the musculature involved in drawing in the scrotum will be reported elsewhere.

MEXICAN LONG-NOSED BAT

Rhynchiscus naso priscus

Numbers of this bat were found in the "sentry boxes" on Orchid Island. As the doors of these small, abandoned, concrete canal markers, the interior is well lighted. Most bats occupying such places are very difficult to approach because of their alertness. Nevertheless, specimens were taken by hand from those boxes not too much infested with wasps!

LESSER WHITE-LINED BAT

Saccopteryx bilineata bilineata

These bats spend the day in places where there is much light. They do not appear to congregate in large numbers. A. B. Howell took four specimens that were hanging on the bare bark of a big tree. Specimens were collected from a shallow depression on a big tree and from the drying shed at the Las Cascades Plantation. As would be expected from this choice of roosting places, they are alert and restless if approached. At this last place, a lactating female with a half-grown young one was observed (May 21). This young one hung head down below the female, clinging to her while she grasped it with one wing. A slight tendency on the part of the females to roost in clusters, while the males were more solitary, was noted. A hollow

tree widely open at the top and filled by the rising waters of Madden Dam contained the largest group located. This group was composed of about sixty individuals.

DOG-LIKE BAT

Peropteryx kappleri

This is another species which occupies places where there is considerable light. A colony was found in a series of small, well-lighted caves located in a hill near the mouth of the Rio Puente. They were very alert, showing their tongues between their wide lips in an amazing grimace, and then flying out into the sunshine and into other chambers when disturbed. Apparently they see well in full sunlight. They evidently had carried espavé beans into the cave, for the beans had been nibbled as is done by *A. watsoni*. A large unidentified snake occupied one chamber of the cave so only seven specimens were collected.

BULL DOG BAT — FISH-EATING BAT

Noctilio leporinus leporinus

Many nights as soon as it was really dark, large, fawn-colored bats were observed flying over the water. They were most frequently seen in the Wheeler Estero where they came either to drink or catch small fish which abound near the surface of the water at this time of day. Dr. Chapman, who described the fish-eating habit of this group at Mono Island (1893, p. 206), was kind enough to spend several evenings in an attempt to collect a specimen. As they come out only after dark and fly very rapidly, we were unable to secure even one. Nevertheless, they could be seen well enough in the moonlight and under the hunting lamp to assign them to this genus, and possibly, to this species which is reported from Panama by Allen and Barbour (1923, p. 270) and has been reported since by Huey (1932, pp. 159-160).

Chapman (1933, p. 133) gives an excellent account of this genus, linking his first observations and doubts as to their use of the interfemoral membrane, and his discovery and observations of this fish-eater on Barro Colorado Island. "Here was proof that they actually ate fish, but thirty-eight years passed before I saw them fishing. Then, shortly after dark, on January 3, 1931, near the mouth of the Wheeler Estero, Barro Colorado Island, by the combined light of a

nearly full moon and a powerful, focusing flashlight, I saw a large, pale bat, about the size of a Nighthawk, which it resembled in flight, course to and fro low over the still water within a few yards of our boat. From time to time it dragged the surface of the water for a distance of several yards with its spread interfemoral membrane, producing a soft, swishing sound which I had heard before I knew its cause."

NICARAGUAN SMALL-EARED BAT

Micronycteris microtus

This bat was found associated with the Mexican Long-nosed Bat in the "sentry boxes" on Orchid Island. Others were secured from the under side of a fallen log as well as in a hollow tree on 23, Pearson Trail. This last group included a lactating female (May 8).

PANAMA SPEAR-NOSED BAT

Phyllostomus hastatus panamensis

This large bat was taken in the caves at Chilibrillo and in old powder magazines near Summit. There is little to add to Goldman's report on the species (1920, pp. 185-186) except that, in captivity, they kill and eat smaller bats, and appear to thrive for some time on carcasses from the skinning table.

Dunn (1933, pp. 188-199) recently published a full account of the carnivorous habits of this bat based upon laboratory observations extending over a considerable period of time. Defibrinated blood, cockroaches, house mice, birds and other bats were eaten when offered. For a period of twenty-five days a specimen ate nothing but banana. When, following this period of fruit diet, a mouse was placed in the cage the bat killed it almost at once although this was done at 10 A.M. This bat ate three mice in one night which suggests the toll it may take of small mammals and birds.

Phyllostomus discolor

This species was taken in numbers from a hollow tree upon the Island. This tree would be occupied from time to time, but the bats would disappear irregularly for long periods, only to reappear later. In an earlier publication, (Enders, 1930, p. 290), the writer listed this bat as *P. verrucosus* remarking on the fact that the Panama specimens were consistently larger than topotypes from Oaxaca, Mexico. Speci-

mens taken from the same tree at a later date were identified by Miller, (1932, p. 149), as *P. discolor*, who said that "they differ slightly but rather consistently from the three topotypes of the Mexican *P. verrucosus* in their somewhat greater size, but in no other characters that I can discover."

RUSTY LONG-TONGUED BAT

Lonchophylla robusta

Several specimens were captured in a net as they flew over a pool in one of the caves on the Chilibrillo.

SHORT-TAILED BAT

Carollia perspicillata azteca

This is a very abundant species hanging up in tunnels, under well protected bridges and in hollow trees. The body temperature in 99.2° with the air at 79°.

Pre-mature parturition was observed on March 15. Females taken that morning in a hand net, and placed in cages, gave birth that afternoon. When born the young were in the intact amnion which was removed by the female. To those observed but one young was born. No young survived more than a few hours from which the fact that they were premature was deduced.

YELLOW-EARED BAT

Uroderma bilobatum

While this bat has not been reported from the Island, it probably occurs there, as this species has been taken in palm trees at Gatun and Summit, and there are many such trees suitable for its use on the Island. Barbour (1932, pp. 307-312) gives an excellent account of the roosting habits of this bat and its utilization of various palms; he also points out the tendency of the males to roost alone while the females roost in clusters.

JAMAICAN BAT

Artibeus jamaicensis jamaicensis

This is another common bat that disturbs fruit bait whenever it can be reached. No roosting places were found. Several specimens

of this common bat were taken in Sherman traps and others in Schuyler and steel traps, using ripe banana as bait. Some of these traps were on the ground, others were in vines and trees. There is a very distinctive and repellent odor.

WATSON'S BAT

Artibeus watsoni

W. Lindsay took a specimen of this bat at Summit, and another was observed several times before it was collected in the Gardens. These bats spend the day clinging to the under side of the banana leaves. It is alert and difficult to approach, and, unlike *Uroderma*, is comparatively solitary. Mr. Lindsay assures me that this bat, too, eats espavé beans, and that espavé seedlings are found under their roosting places. As with the Dog-like Bat, it may be that not enough of the seed is eaten to interfere with growth. Unless it is for food, why do the bats collect the beans? And why do they carry them to their roosting places? The beans are too large to have passed through the digestive tract.

Goldman (1920, p. 204) took a specimen near the entrance to the tunnel of an old mine. That the usual habit is to spend the day under leaves is borne out by Chapman's (1933, pp. 555-556) observations on Barro Colorado Island. He found a solitary individual under the cut leaf of *Geonoma decurrens*. His interesting paper casts farther light upon the habit of cutting leaves so as to form shelters.

MEXICAN VAMPIRE BAT

Desmodus rotundus murinus

These bats appear to occur over a large portion or all of the Canal Zone. Their attacks have been noticed wherever stock has been left unprotected at night. Apparently any mammal large enough to supply blood and more or less immovable while feeding is suitable. Calves in the pastures about Summit appeared to suffer most from the loss of blood occasioned by these attacks while the literature is replete with reports of horses and mules being much weakened.

In 1929, A. B. Howell took four specimens of this species in a cave on Taboga Island. They were roosting in hollow crevices in the caves into which he reached with a pair of long forceps. After the group was alarmed they were far too alert to be secured in this manner. Upon the

invitation of L. H. Dunn of the Gorgas Memorial Institute, a trip was made to Chilibrillo Caves to look for vampire bats to be used in his important researches at the Institute. A few were located in the smaller, more elevated galleries far from the other bats, but we were unsuccessful in capturing any individuals. Their alertness and evident resourcefulness was astonishing. On emerging from the cave we saw a boy who displayed three bites inflicted by a bat during the previous night, one above the left elbow, one between the fingers at the base of the left hand, and one between the toes. They were not bleeding nor did they appear to be severe. The natives in the region about the cave reported bites as being frequent but of no consequence. That attacks are frequent is not to be wondered at as the houses are nothing but palm-thatched roofs with pole sides, or open.

The attack of this bat can be avoided by hanging lanterns near the stock, a practice the worth of which is attested by the experience at the horse barn of the Cattle Industry. The attacks appear to be most frequently directed at certain regions of the body, chiefly below the fetlock and on the neck near the shoulder. This is, possibly, because the bat may hang upside down while feeding and the hair of the fetlock may offer a secure foothold.

A tendency to attack the same animal is marked. Darling (1911, p. 14) notes that sometimes only one horse in a stableful of animals may be attacked, while Lindsay told the writer how feeding bats tended to concentrate upon one of the three animals in the corral in Summit. Thus only one of the mules would suffer while the other two appeared to enjoy an immunity from attack. If the victim was confined and protected as was done if any sign of weakness was noted, one of the unprotected animals would be selected and utilized until it was, in turn, removed. What underlies this choice is not known. Of the feeding habits of the bat, Dunn (1932, p. 423) says:

"The vampire does not suck the blood, as popularly believed, but takes it up with its tongue, seldom placing its mouth on the wound except when the latter is first made or when the bleeding is very slow. If the wound bleed freely, the bat simply laps up the blood, hardly touching the tissues, while if the bleeding is scant the bat licks the wound."

Trypanosomiasis in time proves fatal to infected bats as Dunn shows, but they themselves are capable of transmitting trypanosomiasis to horses or other susceptible mammals. This disease may explain the apparent scarcity of the bat in the presence of an abundant food supply.

DISC BAT

Thyroptera albigaster

A single specimen of this rare and interesting bat was collected on the Island by E. R. Dunn (1931, p. 429). This individual was found in a curled leaf, three feet above the ground. Barbour (Allen and Barbour, 1923, pp. 271-272) captured this species "in the great, dry, curled-up Heliconia leaves."

LITTLE BLACK BAT

Myotis nigricans nigricans

This bat was abundant about the laboratory where the day was spent hanging under the eaves. Two individuals lived inside the laboratory for several months. At times, this bat is very noisy, squeaking and fighting, hanging up on the wire screens with a great noise and then flying off again. These periods corresponded to the fullness of the moon. Another roost of this bat was located in a hollow tree on Orchid Island.

COIBA ISLAND MASTIFF BAT

Molossus coibensis

These bats shared the crevices under the eaves of the laboratory roof with *Myotis nigricans*. They appear to prefer dark places.

CRAB-EATING RACCOON—"MAPACHIN"

Procyon cancrivorus panamensis

Goldman (1920, p. 152) reports taking this raccoon along the Chagres and at Gatun. The writer found crabs dug out in a manner that appeared to be the work of this mammal, for the muddy tracks were those of a raccoon with blunt claws. Later Zetek said that this animal had been reported from the Island. Judging from the location of the diggings, the Crab-eating Raccoon frequents the small streams between Fairchild and Lathrop Trails.

COATI

Nasua narica panamensis

It is difficult to write anything new about the habits of the Coati for of all the mammals on the Island, this one has furnished the most

literary material. They are so abundant, so easy to see, and so interesting that this is only natural. For readers who wish a general account of the species, several accounts have been written, notably by Chapman, (1929, 1931) and Sharp (1930).

To the mammalogist, the Coati is most interesting because of the problem presented by its abundance on the Island. Protected from man, and with an abundant food supply they are far more numerous here than they are elsewhere in the Zone. Presence of numbers is felt all over the Island, but is acute about the laboratory clearing. How any bird or rodent survives is a constant source of wonder, for the Coati is tireless and cunning.

For some years, table scraps were placed in the clearing, and this food supply served to attract the Coati to the clearing. They became so abundant that those in charge decided that steps should be taken to reduce their numbers, so many were trapped alive, transported to the mainland and then released. This had little effect until the practice of furnishing a constant food supply was discontinued. Now, while by no means rare about the clearing, they are not seen so often, and what has been lost by way of their almost constant company has been more than made up by the restoration of more nearly balanced conditions about the clearing.

There are many about the clearing at all times, but their greatest concentration occurs at the end of the dry season. During this period, it frequently happened that eight out of ten traps would show the effect of their attentions. Three times in one day a band of Coati followed a trap line, knocking the traps about and eating the bait as soon as they had been reset. As with the other mammals they desert the clearing when food in the forest is abundant.

The strength of the Coati is astounding. Live traps must be very strongly made to resist tooth and claw. Neither will a small steel trap hold them; a Number two is the smallest serviceable size, but a size larger is recommended.

Not only is the Coati at home upon the ground, among the vines, or in the trees, but it is also a strong swimmer. One large male was trapped unhurt, a patch of fur dyed for purposes of identification, and than transported by canoe to a point some one hundred yards from shore. When dumped into the water he attempted to climb into the canoe and only vigorous use of a paddle kept him out of the cranky craft. After this discouragement he settled down to the task of swimming ashore. He proved to be a strong swimmer. The ludicrous, long nose was curled up well above the water, periscope-wise. On

landing, the Coati shook himself a few times, then walked into the forest; but within a week he was robbing the traps set about the clearing just as he had been doing before his experience.

The Coati is omnivorous. Insect larvae, insects, rodents, star-apples, pineapples, figs, espavé beans, bananas, papaya, palm nuts, almendro—all of which the writer has observed—are eaten, but this list is merely representative, and by no stretch of the imagination exhaustive for the Coati eats almost all foods. How many eggs and birds it destroys there is no way of determining.

There may be two broods per year, or no particular breeding season, for young about one quarter grown were seen in June and February. A pair, possibly breeding, were associated together in July.

KINKAJOU

Potos flavus isthmicus

The Kinkajou is as arboreal as any Island member of the Procyonidae, and surpasses the Crab-eating Raccoon and Coati in this respect. No individuals were observed descending to the ground, all travel being through the trees, as was noted by Anthony (1916, p. 372) at Tacarcuna. They travel and feed only at night—a trait noticed in captive specimens of which pets have been made—but are much more active on moonlight nights than at other times. The days are spent in some dark retreat such as a dense mass of vines or a cavity in a tree, individuals having been dislodged from both types of resting place.

Although arboreal, the Kinkajous are not in a class with the White-faced Monkeys or the Squirrel, for while they move rapidly in trees and vines, progress from tree to tree is made with caution and no great speed. They dash along the larger limbs without using the prehensile tail as a "safety belt" by curling it loosely about the limb, but as soon as the slope is steep the tail is so employed regardless of whether they are going up or down. They run down small trees head first with the tail ready for instant use. Movement from tree to tree is accomplished not by leaping but by first advancing deliberately to the end of a branch then cautiously reaching for the nearest twig of the next tree. A female in moving thus, missed her objective, and as her hind feet were not on large enough twigs to give her a firm hold, her tail, which she had carried around the branch, was clamped down and served to bring her up with a jerk. This was the only time the writer observed *Potos* use the tail for prehension. On the second attempt

she grasped a twig, pulled the branch toward herself and secured a firm foothold before releasing the tail hold she had maintained. This performance in its essential parts was repeated at each passage.

The Kinkajous are most at home among the larger branches and vines. Here they move with speed and grace, leaping about in a very wonderful way on these aerial highways. As their eyes are large and reflect light when they watch the beams of the hunting lamp, their astounding gyrations are plainly seen as they rush about on the larger limbs or up and down the vines.

Anthony (1916, p. 372) reports a group of eight to a dozen individuals coming to feed in a fig tree. While Kinkajous do feed in bands, pairs are more frequently met with, and occasionally a single individual. For example, a pair was seen very frequently about the laboratory clearing—always two, never more. When separated by even a short distance, they called back and forth frequently, the call being a distinctive, plaintive whistle, "quit, quit," which changes in pitch, volume, and frequency when the animals are alarmed or excited. Another pair came to the clearing on the night of April 19. They were very noisy and to judge from observations extending over three hours, were breeding. On two occasions, April 22 and May 1, solitary individuals—both females—were observed. The first one was collected and proved to contain a very early embryo.

As far as the writer's observations go, the Kinkajou is frugivorous. Star-apple, almendro, mango, guava, avacado, and many species of fig are eaten. The insect larvae found in a few stomachs may have been ingested with the fruit, much of which is heavily infested. "Fruit seems to be their principal diet, but they doubtless feed on many other things. One partially filled stomach contained mainly fragments of large insects, but included small *Coleopterous* species swallowed whole." (Goldman, 1920, p. 160).

One was shot while feeding in a mango tree at Las Cascades Plantation. Feeding in the same tree with it was another Kinkajou and a Brown Opossum (*Metachirus*). When balsa is in bloom Kinkajou visit the trees nightly going from flower to flower, searching apparently for the insects within.

BASSARISCUS

Bassariscus sumichrasti notinus

One day, while shooting bats from a cavity which was located about twenty feet above the ground in an espavé tree growing at the water's

edge on Orchid Island, a *Bassariscus* was dislodged. It climbed slowly out of its resting place in the cavity and disappeared, although it was not seen to leave the tree. The size and color of the animal, and the large ears, together with the long, conspicuously ringed tail leads to this identification, which, if correct, adds considerably to the known range of this animal. As the writer was using nothing larger than a .410 handy-gun with small shot, no attempt was made to collect the specimen. Later another individual, believed to represent this species, was observed as it ran along a high limb. When it reached the end, it moved into the next tree, passing rapidly along the larger portions of the limb, but moving more cautiously when at the ends of the branches.

OTTER

Lutra repanda

The Otter is fairly abundant on the Chagres River and various of its tributaries including the Chilibrillo. Glimpses of them are caught as they bask or eat on gravel bars or rocks, but they are very wary and cannot be approached. The men engaged in the Hydrographic Survey who travel up and down the rivers see them frequently but do not secure an opportunity to shoot them as they slip into the water before a cayuca can come within range. William Halloran reported seeing a pair about a snag on the Chilibre River under which, according to his rivermen, they had their den.

Goldman (1920, p. 165) reports that "near the mouth of the Chagres River they live along the banks and creeks up which the tide runs for some distance." Apparently they frequent running water for they are always found where there is considerable movement in the water. No signs were found about the Island, and Sylvestri, who was familiar with them on the upper Chagres, agrees that they do not occur on the Island. They are reported to be abundant on the Pedro Miguel River.

TAYRA — BLACK CAT

Tayra barbara biologiae

All of the specimens seen on the Island were black headed, but the degree of blackness differed with individuals. A large male weighed fifteen pounds.

During the writer's stay, he saw but two Tayra, and both of those within a week. They are not shy animals and they move about freely

during the day, so they cannot be very numerous. Nevertheless, five have been seen in one group here. They were growling and spitting at each other when surprised. This is not unusual; in another part of Panama, Carpenter shot two out of a tree where they had been fighting. It is possible that this habit of congregating has to do with the breeding habits.

Here is another animal that is always pointed out as a poultry and bird killer, yet a careful examination of the entire digestive tract of the two specimens taken on the Island revealed nothing but fruit pulp of a very agreeable odor. A few pupae of insects were also present, but these may have been in the fruit. Clark reports that the stomachs and intestines of two he examined contained food entirely of vegetable origin. That the Barro Colorado Island specimens were not forced to such a diet was evident from their excellent condition. Chapman (1929, p. 362) states ". . . there can be no doubt that the Tayra should be ranked among the enemies of tropical birds, and with it we may head a list of their foes. Among mammals may be added the Grison, Opossums, Coatis, Skunks, Ocelots, Yagouarondi, Puma, and Monkeys."

Both specimens observed were traveling at a rapid rate along the forest floor and paid not the least bit of attention to the writer. Neither traveled in a straight line, but went from log to log in a zigzag course. On reaching a log, they bounded easily upon it, ran along it to the end, jumped down and ran to the next log. On the ground progression was made by a series of bounds. Their motions were beautiful and bespoke great muscular power. The source of this power became evident on skinning; the muscles of the neck were so heavy that the diameter of the neck was greater than that of the head, while the pectoral muscles stood out an inch above the surrounding structures.

About one specimen there was a pleasant, musky odor rather sweet when not too strong, but another male was as rank as any weasel. The first met instant death but the second screamed and bit itself before dying so may have released some of its glandular secretion. Aside from this musteloid odor of one, they were much "sweeter" than carnivores usually are. The feet were full of spines of the black palm, and the ubiquitous ticks were found between their toes. The duodenum contained several acanthrocephalids, *Oncicola sp.*, which, according to E. W. Price who identified them, may possibly represent a new species. The ectoparasites have not been determined as yet.

R. Hartzell reports that he found a nest of this animal in the tall

grass of the Cattle Industry pasture near Summit which contained three young. There was no excavation nor protection of any type to cover the nest aside from the heavy, overhanging grass. They are numerous here as well as at Alhajuela. One of the silver men living at Candelaria said that Tayra bothered his poultry, that a fox terrier would pursue such individuals which promptly took to a tree staying there while the dog barked at the base. When one realizes the strength of these animals, it is astonishing that they should "tree" for a dog.

GRISON

Grison canaster

This species is recorded here since a few individuals have been found in the Zone, but they appear to be rare. Those who have kept them as pets report that young individuals are very well mannered and playful.

PANAMA BUSH DOG

Icticyon panamensis

Questioning of hunters who had been up many of the rivers of the Chagres drainage system resulted in a distinct impression that the Bush Dog found by Goldman to range north to Mt. Pirre may be found nearer the Canal Zone. A companion reported hearing several short barks at Peluca, describing a series of sounds that I had heard the day before. These may have been made by a bush dog for there were no domestic dogs in the region or they may have been some other unrecognized animal.

JAGUAR

Felis centralis

Although no one has seen the Tigre on the Island nor secured a flashlight photograph of it, it is included in the list of the mammals of the Island for the writer is convinced that it is a visitor.

It has been a growing conviction of the writer that among the larger tropical American cats the habits having to do with defecation differ to such an extent that the dung may be identified by size, location, and the treatment of the area after deposit. Thus the Ocelot may return to the same spot time and again until a consider-

able deposit accumulates; and there is no attempt to cover the material. The Puma, on the other hand, makes no such deposits, and makes a feeble attempt or none at all at covering; this much is a matter of observation. A third type of feces was found that surpassed in size all the others and these, located in the more remote areas of the Island, were well covered with forest litter. These may be the feces of the Jaguar.

"Few predatory animals are such wanderers as the Jaguar, which roams hundreds of miles from its original home, as shown by its occasional appearance within our (U. S.) borders" (Nelson, 1918, p. 413). This agrees with observations made in widely separate regions and there is no reason to believe that the same habit does not exist in the Canal Zone. Goldman (1920, p. 167) tells of reports of the Jaguar killing cattle on the savannas between Chepo and the city of Panama, also (p. 166) that it is well known to native hunters, favoring districts where deer and peccaries are abundant. Cattle have been killed in the pastures not far from Summit even more recently. Thus Barro Colorado is well within their range and there is an abundant food supply to attract the large cats.

Barro Colorado is an island, but water is not an impassible barrier to the tropical cats. While the writer was unable to verify a statement attributed to a Canal pilot, who claimed to have seen a large spotted cat swimming across the Canal, well substantiated reports from other tropical regions lend credence to this. Thus Holt (1932, p. 72) in his summary of the literature of instances of voluntary swimming on the part of the larger cats adds to Humboldt's report his own experience of Jaguars swimming. He quotes Seton (1925, vol. 1, p. 24): "It seems to be a rule that none of the tropical cats have any fear of water. It is well known that all of the felines love to be warm. They have not the fur to resist the wet, so in cold regions avoid the water. The Jaguar in its equatorial home is credited with many aquatic ways. It will swim rivers of any width when they lie across its path. It will dash into the water to attack an enemy, and is said by many observers to be an adept at catching fish." With such a habit, would it be surprising to find the signs of an occasional Jaguar when one considers the stillness of the water, its warmth, and the narrowness of some of the channels separating the Island from the mainland, coupled with an abundance of game and freedom from molestation?

Sylvestri, without any knowledge of the writer's notions on the subject, assured Dr. Barbour and me of the presence of the Jaguar

on the Island, saying that he had seen signs on some of the more remote portions of the trails. These locations were the same as those where similar signs had been seen by the writer a year or so before Sylvestri came to the Island. It was these signs that had convinced me. Moreover, Sylvestri went on to tell of the habits of the various big cats including the depositing and covering of their dung which corresponded with the observations set forth above.

On the other hand there is considerable negative evidence which has not been dismissed lightly. Old Mex, an experienced hunter, insists that no Jaguars reach the Island. As his experience on the Island was limited to a few weeks, it might be that during that period none visited the Island, or that he might have overlooked the signs. Chapman (1929, p. 217) refers to its cry, remarking that "it seems probable that if this animal were on the Island, sooner or later we should have heard its voice," adding, however, that the Jaguar "is first among the possible prizes awaiting the flashlight photographer on Barro Colorado." All the signs seen or reported are from the areas remote from the laboratory and, despite statements to the contrary, sound does not carry far in the dense forest, so the cries may not have been heard at the clearing. Moreover, Rben (1934, p. 30) in writing of another sub-species of this cat says: ". . . yet jaguars remain in considerable numbers, unseen and usually unheard" in the Pantanal of the Upper Paraguay.

Apparently, White-lipped Peccaries are more abundant in those portions of the Island where Jaguar signs have been seen than elsewhere; to judge from the signs, Tapir, too, are more numerous here than in less densely forested portions of the Island; Brocket Deer have been seen in no other place; while Agouti and Paca are also found here as are all the species of monkeys occurring on the Island; neither is it shunned by the Collared Peccary or the birds, et cetera, said to serve as food. (Seton, 1929, vol. 1, part 1, p. 23).

The dung considered to be that of the Jaguar is large in diameter, larger by a half-inch than that of the Puma. It was deposited at the side of the trail near logs and was well covered by leaves. The marks indicated an animal with a considerable reach, well developed claws, and a paw about five or five and a half inches wide. The claw marks were deep at the beginning of the sweep becoming shallow and disappearing before reaching the heap.

The dung could not be attributed positively to the Jaguar for it contained much of the same material found in that of the Puma. Peccary hair, species undetermined, and Agouti hair constituted

the bulk with a trace of Brocket, and, possibly, Three-toed Sloth of which there was very little. Some vegetable matter — roots — was included, probably by accident. Only three examples were seen and collected so the list is very incomplete. They were seen in July and August, 1929, on Miller Trail and in a ravine crossed by the Nemesia Trail. Similar dung, covered in the same manner and with plain tracks leading to the spot, was pointed out to me on the Pequeni River by another hunter. There was a clear area about the dung where the debris of the forest floor had been scraped over the pile. The hunter insisted, and the tracks supported his contention, that the dung was that of a tigre. He said that urine was sometimes covered in the same manner.

Old Mex insisted that Jaguar could be decoyed into range from a considerable distance but did not attempt it on the Island. This is done much as described by Nelson (1918, p. 413), taking into consideration the conditions imposed by a dense forest as against a canyon country. Moreover, instead of using a trumpet, Old Mex constructed a call by hollowing out a piece of balsa log six by twelve inches, and covering one end with dry deer-skin much as one would make a drum. Through the drum head he passed a thong which was knotted to keep it from slipping through the skin. In using, the call was held tightly, the right hand passed into the uncovered end of the call, and the thong caught lightly between the fingers as they slipped down its length. Some substance placed upon the thong made the fingers slip along it as though it were rosin-covered. At each stroke of the fingers the call gave a soft, far-reaching, mellow note, not unlike the calling of a domestic cow. This was repeated slowly at first and then more and more rapidly as the thong was slipped through the fingers repeatedly. This call is effective, whether or not it is an imitation of the female's call at oestrus as Old Mex says it is.

OCELOT

Felis mearnsi

“The Ocelot coat is the most wonderful tangle of stripes, bars, chains, spots, dots, and smudges. It has generally four stripes on the neck, two or three long links of black sausages down the back, and along the sides, chains of black-edged, brownish blotches which look as though they were put on as the animal ran by. All else is dabs, smears, and broken rings.” (Seton, 1929, vol. 1, p. 141). And

withal, a mature male Ocelot from Panama is the handsomest cat of them all. A young male taken on the Rio Puente had the markings but the ground color was more pale than a mature male taken on Barro Colorado. The ground color of the latter was a richly golden orange that seemed to glow. The fur is well kept, glossy, but not deep.

The Ocelot of Panama is a large animal; the adult male referred to above weighed 34 pounds while the two year old male weighed 28. The only other spotted cats with which it might be confused are the Jaguar which is a much, much larger animal, and the rare long-tailed cat, the tail of which is much longer than that of the Ocelot.

Although the Ocelot may be strictly nocturnal where hunted, it is not so on Barro Colorado, nor in all parts of its range. "Several ocelots were seen during the day. . . . On several occasions while hunting in the forest I had glimpses of ocelots crossing small openings among trees, but none were encountered while using a hunting lamp at night." (Goldman, 1920, pp. 167-168). Osgood (1912, p. 60) reports seeing an Ocelot at midday. This is true of Barro Colorado; the only specimen trapped was taken between 11:00 A.M. and 4:00 P.M., and those observed were seen before 9:00 A.M. However, Dr. Chapman took flashlight photographs of two Ocelots at night — one at 2:00 A.M., which indicates that they may move about at all hours.

In another instance, an Ocelot deposited dung on the steps leading up to the laboratory some time between 2:00 A.M. and daylight, as the deposit had been made after the last rain which the gage recorded as having stopped at 2:00 A.M. The specimen secured on the Rio Puente was shot at 2:00 A.M. and another "shined." Thus it appears that they may be about at any hour of the day or night. This is borne out by their food habits, for some important food animals, such as the Agouti, are diurnal, while others, like the Spiny Rats and Paca, are nocturnal.

The Ocelot spends his life in the forest, but a few venture away from cover. Together with Jaguar and Tayra it is reported as having been seen in the pastures near Summit. Here there are bands of timber along the steeper slopes and, when the grass is high as it is from May until the following dry season when the land is burned over, there is excellent cover. Fire does not, however, destroy much of the forest cover in the ravines. On the ground the Ocelot can travel very rapidly. The individuals observed by the author were seen climbing down to the ground upon reaching which they ran away. Once the cat waited until the observer had passed before

coming down. This tendency was noted by Goldman (1920, p. 168), ". . . but when discovery became certain they ran down the trunks of the trees to the ground." The Ocelot is very inconspicuous unless in motion, so many must be passed without being observed. This habit of resting on stubs, high logs, and big limbs has won for them the reputation of lying in wait for prey which is, possibly, well deserved. It is also probable that the Ocelot does some hunting in the trees for they appear to be good climbers. Carpenter (1934, pp. 121-122) records one such individual attacking a young howling monkey. But the examination of the foods most frequently eaten leads one to believe that most of the hunting is done on the ground.

The natives with whom the disposition of the Ocelot was discussed, all stated that he was not dangerous, but was more so than the Puma, for he could not be trusted even free in the forest. They could not give any reason for belief nor recall of anyone being molested by this cat, however. They disagreed with Seton's statement picturing the Ocelot as "a big, simple-minded, good-natured cat." (1929, vol. 1, p. 146). Some pets seen by the writer were very friendly and good-tempered, while others were not. There appear to be more Ocelots kept as pets than Pumas, which may be because of their greater abundance as well as their smaller size.

The anatomy of the Ocelot is well worth a few comments. The forepaws are much larger than the hind paws, so much so that one common name is "Manigordo" meaning "fat-paws." Most illustrators show the Ocelot as a slender-necked cat; when the head is thrust forward as in hunting this is true, but it is not true in repose or when the head is held high. When the skin is removed the development of the neck muscles is such that the neck is larger in diameter than the head and may be as broad as the trunk. Thus, for its size, the Ocelot has a very powerful neck. The muscles of the forelimb and pectoral girdle display a considerable development indicative of a powerful climber.

Of all the mammals of Barro Colorado, the Ocelot offers the easiest subject for a study of food. This is the outcome of a habit that is, as far as the writer knows, unique among the cats — the habit of depositing dung in a suitable spot and returning again and again to add to this deposit. The resulting accumulation may be made by one or many individuals; nevertheless such a deposit furnishes a good idea of the food of the Ocelot. These deposits are not difficult to find, nor are they rare on Barro Colorado. They must exist wherever the Ocelot ranges even though they have not been reported.

By far the largest deposit was found in the hollow end of an almindro log resting ten feet above the ground within 100 meters of the laboratory. This accumulation yielded about a half peck of feces. Another spot so used was on Orchid Island in a concrete "sentry box" which, on being discarded, as a marker in the Canal, was placed there along with other unused materials. Other deposits were found on the steps under the doorway of the rear light at the end of Miller Trail; at the toilet of Fuertes House, at the toilet of Shannon House, located at the edge of the laboratory clearing, at the toilet at Redwood House, and under Bangs House. A single defecation took place under a shelter on the steps leading up to the laboratory; this was removed and no more were made while the writer was there.

The one thing all these accumulations had in common was their location under shelter and in such a place as to enable the animal to back up to some object such as the end of a hollow log, a post, or a door before defecating. The larger collections were in the better protected places and smelled of urine as well as fecal matter. When on concrete, urine was sometimes seen as well as noted by odor.

What can be the reason, the purpose of these deposits? Why are they so frequently associated with toilets? Are they the work of one or more individuals? The observations of the writer lead him to believe that Ocelots hunt in pairs under normal conditions, and stick to a given territory, and that these heaps serve the purpose of "sign posts" where he who runs may read. Since such a "sign" is made in sheltered spots it is preserved for some time even in this region of heavy rain. The odor of such deposits is to the human nose remarkably like that of the concrete-pit toilets used on the Island. Can it be that dung and urine are voided in response to this odor? How else can one account for the occurrence of dung at so many of the toilets when the nearby houses — used infrequently — offer all the conditions save the odor?

It is not possible at present to state whether or not these accumulations represent the dung of a single individual. If they mark the territory of an individual or pair they may be, but if they are "sign" of all Ocelots passing, they do not. The fact that there will be no feces deposited for some months when a deposit is removed only complicates the problem.

Another habit of the Ocelot is the clearing of space upon which to urinate. The urine is not covered after voiding, leaving the area bare. Whether this habit has any significance or a significance

similar to the depositing of dung was not determined. Because of the transient character of these deposits and relative inconspicuousness of these areas, no systematic study of the habit was made. Chapman (1932, p. 471) refers to these bare spaces on the forest floor saying that they are somewhat similar to the courts made by the Gould's manakin.

With these accumulations of feces so easy to secure, the food habits of the Ocelot can be learned without much difficulty. The food recorded here is based on examinations — some very carefully made in the laboratory, others in the field — of approximately fifteen piles, and the stomach and intestinal contents of two specimens.

First on the list of foods is the Spiny Rat, for all deposits contained the hair, spines, and bones of this octodont. Next in point of abundance of remains was Agouti. These two mammals constituted the bulk of the food in most cases. Snakes and lizards also constituted a considerable item, as did the Paca. Peccary hair, probably that of a young Collared Peccary, was found, as well as hair from the belly of the Brocket Deer. The Rio Puente specimen had made a meal of rabbit, *Sylvilagus gabbi gabbi*. Another specimen had eaten a Coati, while a third had suffered from a brush with a porcupine. Remains of *Oryzomys*, species unidentified, were recovered in several cases. While the Ocelot probably eats any reptile, bird, or mammal that it can overcome, no bird remains were found. A study of the food leads to the conclusion that the Ocelot hunts usually on the ground and does not catch birds often. On Barro Colorado Island, the Ocelot could live on a diet of Spiny Rat and Agouti alone. Their reputation as killers of birds and poultry is, the writer believes, unjustified.

One of the largest piles of dung was located on Orchid Island. This is too small an area to support a cat the size of an Ocelot, so the beast must, perforce, have swum back and forth between Orchid Island and Barro Colorado Island, or over to De Lessup's Island, and then across the Canal to the mainland. Orchid Island is separated from Barro Colorado Island by about one hundred yards of water; De Lessup's Island is about seventy yards away, while the Canal is one hundred sixty-eight yards wide at this point. Thus, to reach the mainland and an adequate food supply, the Ocelot must have navigated at least one hundred yards of open water at each crossing.

But the Ocelot is not always at home in the water. According to Donato and Sylvestri, during the heavy rains of November, 1931,

a cub was washed out of a den located on the stream to the east of the laboratory, and, in the course of its going downstream, was caught in some vines. Although the female called and stayed near the spot where the cub was entangled, she made no effort to dislodge the young one which was swept into the lake and finally drowned. Sylvestri as much as said that a man would have been a fool to have attempted a rescue with the mother about. The cub had only milk teeth.

Three nursing cubs were captured by a native near the Rio Gigante on February 28. Thus there may be two litters per season, or the young may be born at any season.

After the capture of the only Ocelot taken on the Island (Enders, 1930, p. 289-290), another came down the trail at dusk to within a few hundred feet of the laboratory, calling as it came. The call was much like that of the house cat, with due allowance made for the difference in size, and was more similar to the note ending in a rising inflection — like a distinct questioning, uttered when the animal is looking for other cats — than a yowling or fighting note. It was thought that this individual was a female, possibly the mate of the captured specimen.

The other specimen taken (on the Rio Puente) was definitely associated with a female larger and probably older than he. As he was fully adult — the testes were large and functional, although the cat was not fully mature — being at least two years old, it is hardly possible that they were mother and son.

These two cases combined with the calls and answers heard from time to time lead one to believe that Ocelots may hunt together or at least be companionable at certain times. The relations of the father to the cubs are not known.

All this is borne out by Azara who in writing about the Ocelot in Paraguay, says that they pair, and that "each pair lives in a separate district as may be inferred from a male and female . . . always being caught on the same spot." (1801, pp. 226-227). Lacy (quoted by Seton, 1929, vol. 1, p. 152) says "they often go in pairs."

How many Ocelots are on the Island? Few have been photographed, and only Carpenter and the writer report seeing any. But the tracks and dung deposits are abundant. Dr. Chapman photographed two on the same night no great distance apart — both appeared to be males. It may be safe to assume that they were not visitors to the Island although it was several seasons before another photograph of an Ocelot was secured.

Without assuming that Ocelots pair as Azara says, and as the writer believes they do, we have two as the minimum population of a rather restricted area. Add to these the Orchid Island Ocelot, and the one that used Fuertes House toilet and the rear light at Miller Trail, as well as the maker of the signs near the laboratory; and the Island has a population of five. This assigns no Ocelots to the vast eastern portion, nor the still vaster, densely forested western portions of the Island. The writer believes that no fewer than eight Ocelots live on the Island, and that twelve may be an understatement.

After an Ocelot is grown there is little to fear on the Island. The White-lipped Peccary could be avoided as well as, possibly, large cats. The many ticks found between the toes and in the pectoral and inguinal regions cannot be a great drain on the individual. Intestinal worms were found in both specimens dissected, but the animals were in excellent flesh. A few might suffer from attacking the porcupine, or from the spines of the black palm which were found in most of the mammals. The writer suspects that when the pressure of population becomes great, the surplus Ocelots swim to the mainland where they come in contact with their greatest enemy, man, from whose attack they are free on the Island.

PUMA

Felis bangsi costaricensis

The Puma is seen more frequently on Barro Colorado Island than any of the other cats. This may be because of its habits or numbers. Elsewhere in the Zone the Puma is a rare animal because of its pursuit by hunters. Chapman (1929) records a Puma about the clearing watching a tame deer and has published flashlight photographs (1927, 1929) of Puma. He has seen Puma on at least one occasion. Others, too, have observed these big cats, and their tracks are seen frequently. The following communication from Carpenter is of considerable interest:

"I have frequently observed indirect evidence of pumas on Barro Colorado Island during my stay of over five months. These indications were fresh tracks, the squeal of a peccary, partially eaten animals which had been killed, and skulls from which the flesh had been torn a short time previously. Several times I had seen puma tracks coming from overhanging banks and from these I inferred that this kind of a place was frequented often by them. About one o'clock in an

afternoon of the spring of 1932, I was inspecting a dugout of some animal. The tunnel ran downward and inward toward an overhanging bank that was covered by masses of roots. As I raised myself from making an examination of leaves, tracks, and soil, I saw the head of a puma emerging from the bank some fifteen feet away. The animal then moved out in full view. From his size I would judge that he was an adult. He was beautiful. The dorsal portions were a deep reddish or chestnut brown somewhat similar to that of a forest deer. This deep brown became lighter and blended with whitish trimmings along the ventral surfaces of the belly, limbs, and head. His ears were erect and carried in a cat-like position, whereas his tail formed an upward-turning semi-circle. The animal moved slowly away, across a small stream and up a steep bank some twenty-five yards distant. Here he stopped and remained sideways, with his head turned, looking in the direction of the observer. For about one and one half or two minutes he remained still; during this time I focused my field glasses on him and these glasses seemed to bring him within reach of my hand. The beauty of his form and coloring, the grace of his movements, and the direction of his behavior away from the observer provoked no fear but great admiration and wonder."

As Carpenter indicates, the peccary is eaten, although the hair of the Collared Peccary alone has been found in the dung. The White-tailed Deer is eaten (Chapman, 1929, p. 207), as well as the Brocket. Chapman has observed a Puma eating a sloth which it may or may not have killed. Nor is smaller game scorned, for remains of Paca, Agouti, Spiny Rat, Iguana, and snake are also found in Puma dung. In food habits it differs from the smaller Ocelot, chiefly in the higher percentage of large game, and is certainly not the equal of the Ocelot in catching the smaller rodents.

Nothing is known about the home range of the Puma on the Island. It is suspected that individuals tend to frequent the same lying-up places but that they range all over the Island. It is not improbable that they swim from island to island or to the mainland. While they range all over the Island, tracks are most frequent in the more densely forested portions. As Carpenter says, Puma tracks are seen leading from overhanging banks, and Mexico saw a Puma leave such a resting place at Zetek 11. We returned several times but did not see him again. These resting places are often located where roots of a tree have stopped erosion at the head of a gully. Such a place is dry, is protected on many sides, affords a view of whatever passes up and down or across the gully, and offers a route for an unostenta-

tious retreat if the animal is alarmed. A large animal, possibly a Puma, was dislodged from a large hollow tree which offered similar protection at Pearson 22.

That the Puma is not strictly nocturnal is borne out by no less than six observations made on the Island, and the fact that Chapman secured an automatic photograph of a Puma at 11:00 A.M.

Dr. Chapman in a letter to the writer states: "You will remember that the first year I set camera traps I got five pictures of Puma, representing, in my belief, four individuals. I had only two traps, and the approximately eight or ten stations in which they were placed represented, of course, only a very limited area on the Island. Unless, therefore, Puma cover a wide territory in the nocturnal rambles, the four individuals photographed could have been only a part of the total Puma population which, at that time, may possibly have reached twelve individuals. This, of course, is pure guess work." We do not agree that it is "pure guess work," for this estimate is carefully arrived at by an experienced student of tropical life. Carpenter believes that eight or ten Puma are on the Island; Zetek believes the number to be higher; while the writer estimates the maximum number at sixteen. This last figure may be high, but it must be borne in mind that the food supply on the Island is large enough to support a larger population than this.

While the writer can judge only from indirect observation, he believes that the Puma is not increasing greatly. What factors limit the increase or lead to an almost stationary population are not known.

On several occasions calls have been heard that were, possibly, Puma. While the sound is easily distinguished from the call of the Ocelot, it is difficult to describe. Calls were heard only at night and chiefly in the region of the valley extending from Pearson, parallel to Miller and down to Nemesis Trails.

YAGOUAROUNDI

Felis panamensis

Although the Yagouaroundi has been reported several times as a member of the Island fauna, it is to be suspected that the animal so represented was the more readily and frequently seen Tayra. It is included in the writer's list on the basis of observations of Ray Carpenter who saw, on four occasions, a cat-like animal running along

the branches and feeding upon figs in company with the Howler Monkeys. Each time the observation was made in late afternoon. Descriptions of the color, size, tail, type of foot, and method of feeding, as well as locomotion, establish the animal as a cat, and not a *Potos* or *Bassariscyon*. Moreover, Carpenter was familiar with the Kinkajou. Even though Carpenter is not, the writer is convinced that the animal was a red color phase of the Jagouaroundi. That it was eating fruit is no great surprise, as several of the Central American genera of carnivores do it.

GEOFFROY'S SQUIRREL MONKEY, TITI

Oedipomidas geoffroyi

On Barro Colorado, the so-called Marmosets are seen frequently, but they may not be as numerous as the Howler. Elsewhere in the Zone they are by far the most abundant monkey for they occur in small second growth that is shunned by the larger monkeys, nor are they as easy to locate as the Howler, nor as eagerly sought for food as are the others.

The name of Squirrel Monkey is very fitting for, when they are seen far up in a large tree, or running along vines, or leaping, their color and tail, as well as size, give them a marked resemblance to the squirrel. In fact, the only specimen of this species collected on the Island was shot as a squirrel, the mistake not becoming evident until too late. These animals are lacking in the characteristics that make the other monkeys of such great interest. The voice is weak, their size small, and they lack the dashing activity of the White-face, and the gentleness of the Night Monkey.

On the Island, Squirrel Monkeys are seen almost everywhere, for second growth is as much frequented as the deeper forest. In fact, the deeper forest does not contain many for they appear to seek trees of smaller size, often near or about clearings. As Chapman notes (1929, p. 284), "They travel . . . usually at mid-forest altitudes and sometimes through the lower growth." Barbour (1923, p. 273) reports their coming into low bushes along the Sambu River. Similarly, they were frequently observed in the trees on the banks of the many esteros of the Island, as well as in the low growth along the stream from Las Cascades Plantation. Here numbers were seen in the growth that was impenetrable but not more than fifteen feet high. Numbers were observed in the rather small growth along

the Chagres, as well as that surrounding the natural savannas near this river.

This monkey is by no means as well adapted to the arboreal life as the White-face or Spider, and probably not as well adapted as the Howler. The toes, with the exception of the great toe, end in claws which, while useful in certain types of climbing, do not give the animal the purchase upon a limb so necessary for a truly arboreal type of primate life. Even in leaping, the feet and tail are disposed as much after the manner of squirrels as primates. In moving along a small limb the weight is carried on the foot which is placed at right angles to the limb, the claws pointing outward, the feet being advanced alternately. As a limb becomes more nearly perpendicular the angle is reduced until, in climbing, the claws take much of the weight. However, if the limb is large and not too much inclined, they gallop along, putting down the forefeet together, reaching forward with the hind feet together, and repeating. They do not give the impression of speed. No leaps were measured, but several were observed leaping from tree to tree across narrow esteros. Sylvestri says that they can swim well.

Most of the Squirrel Monkeys seen are in small bands, numbering up to a dozen and more (Chapman, 1929, p. 284). Sometimes single individuals are observed and very frequently, two. Whether or not such animals represent pairs was not determined. Many times attention is drawn to these groups by the chatter of the animals as they scold, and the noise made as they scurry from limb to limb apparently attempting to secure a better view. Even when not disturbed, the larger bands do considerable calling in a very high pitched, squeaky tone, possibly to maintain communication with the others of the party. Such bands are composed of animals of both sexes.

There appears to be a fairly well-defined breeding season in February, or even earlier. Many specimens taken from that month to June were pregnant. Birth takes place sometime in June to judge from the size of embryos at this time of the year. There are usually two young. Much work on the embryology of this species has been done by Wislocki.

Wislocki (1930, pp. 475-483) describes the glands found in this species. These are "complex scent glands, located in the pubic region, on the genitalia, or in the perineum" (p. 480). Both sexes have them, but "They are much more extensively developed in the female than in the male. . . . The finding of complex genital glands in marmosets is in keeping with the belief that the organization of the

animals is primitive and that they (Hapalidae) represent the lowest order of the Simiae." (p. 481.) A captive female was observed rubbing this gland along the perches in her cage. This behavior was frequent. What role this gland plays in the life of the animal can only be surmised until further observations of animals under natural conditions are made, as well as a study to determine its relation, if any, to the oestrus cycle and breeding behavior.

•A wide range of food, both vegetable and animal, is eaten. The only stomach examined contained some unidentified seeds. Star-apples and figs are eaten as well as a variety of flowers. A band visited the balsa tree blooming near the laboratory with great frequency, as well as blooming cecropia trees. These visits may have been to drink the water that accumulates in the blossoms, to eat the flower, or to search for the insects found there. Some termites are secured by pulling apart dead leaf stems. Captive animals were very fond of insects, chiefly grasshoppers.

It is doubtful if this monkey is carnivorous, in spite of its insectivorous habit. They will eat cooked meat, but were never observed to more than sniff at it in the raw state. Mr. Zetek handed one captive specimen a bat (probably *Myotis nigricans*) which it took between its paws, turning it over and over to examine it, but making no attempt to molest it until the bat nipped a finger. With great rapidity the monkey bit the bat's head, crushing the skull, and then tossed the dead body away, taking no more interest in it. When sloths were confined in their cage, the marmosets would hunt insects in the long hair of the non-resistant sloths.

PANAMA HOWLING MONKEY—MONO NEGRO

Alouatta palliata inconsonans

Any contributions from the writer would be mere fragments when compared with the invaluable work of Dr. Ray Carpenter on this species. Because of his work the life history of the Howling Monkey is better known than that of any other mammal on the Island. The writer would add that man is a great, possibly the greatest enemy of this mammal. Thus a hunter reported that, having hunted for hours without success, he and his companions came upon a band of Howlers. They vindictively shot seventeen.

Lawrence (1933) has recently clarified the taxonomy of the Howlers of Panama.

CANAL ZONE NIGHT MONKEY — MONO DEL NOCHE

Aotus zonalis

The natives on the Chagres insist that there are two species of Night Monkey differentiated on the basis of size, but those shown specimens cannot distinguish them on any other ground. The Night Monkey is strictly nocturnal, although one has been observed moving about after daylight, and is the only monkey on Barro Colorado Island that appears to have a definite sleeping place. This home is usually a hole high up in some tree or in a dense tangle of vines in the tree-tops. Nor do they move about in groups larger than family groups. These habits make them difficult to see unless one is familiar with their nesting sites.

As would be expected from a knowledge of their habit of living in holes in trees, they are limited in distribution to the more mature forest where such cavities are found. Here families were found living within a hundred meters of each other which may indicate a greater density of population than actually exists. Nevertheless, they cannot be called rare. When a suitable cavity is located and the animals take up their abode there, considerable disturbance is required to drive them away. For example, the animal, or animals, occupying a cavity in a branch stub near the laboratory were disturbed frequently when visitors pulled a rope attached to a nearby tree. This was done during the day to alarm the monkey whose face, when so disturbed, would appear at the opening to stare at the intruder; nor did the glare of a hunting lamp appear to disturb them to the extent of driving them away, either in their home or when feeding or at play.

The Night Monkeys about the laboratory appear to move about in pairs. This was also indicated by the fact that the hunters usually secured a pair at a time except when the young were with the parents. The data at the writer's disposal indicates that usually but one young is born at a time, and this one in June. Copulation was observed in December by Dr. Chapman. No pregnant specimens were secured after the twelfth of June. If December is the breeding season, this indicates a gestation period of approximately six months.

The young remain with the parents for some months, probably until the next breeding season. This tendency to live in pairs is noted by Allen and Barbour (1923, p. 273), and of the parents to be accompanied by young by Goldman (1920, p. 225). On June 12, a large non-gravid female was collected with a smaller male, evidently

immature. There were no indications that there had been a recent parturition, so it is possible that the male was born the previous year and because the female did not breed, remained associated with her.

July 2, 1929, a quarter grown Night Monkey was secured by hunters who shot the mother and captured the baby clinging to her. She was kept in the laboratory where she grew very rapidly on a diet of evaporated milk and bananas. During the day most of her time was spent in a hammock in her cage, for she was not active during daylight unless hungry or cold. When either of these sensations disturbed her, she would be restless and whistle and chatter until fed or covered. She was very sensitive to cold, for on dark, rainy days when the temperature dropped to between 74° and 78°, she would shiver and complain unless covered. When active at night, similar temperatures did not appear to affect her. Under forest conditions the Night Monkeys must encounter even lower temperatures, as temperatures of 69° have been reported over some of their range.

The greatest fear displayed by the captive specimen was when she was placed on the floor or the ground. As soon as the hand was removed she set up a great chattering, punctuated by a whistling "Khoo, khoo," and made for the nearest pair of legs. Up these she would climb, not resting until she was perched upon a shoulder. Photographing her was a problem for she would leap to the shoulder of the photographer whenever he approached within three and a half feet. Her vision was not adversely affected by sunlight, for she could follow every movement and could judge distance to a nicety; nor did she ever make any mistakes such as running into objects or taking hold of or climbing anything but human legs.

Altogether the Night Monkey is singularly peaceful and attractive.

WHITE-FACED MONKEY — PANAMA WHITE-THROATED CAPUCHIN

Cebus capucinus imitator

This is the "mono cariblanco" of the native. While there are many on the Island, they are very rare in other parts of the Zone. This may be due to their being much hunted both for the sake of capturing immature animals for sale as pets, or for food.

This monkey moves about in bands which are surprisingly large and which trail along for distances over a quarter of a mile. Such groups are difficult to count for they are much scattered and may contain as many as thirty or more individuals. On several occasions

a solitary male was seen, but the usual group numbers about eighteen to twenty-four. The territory over which such a group ranges is very much larger than that of a clan of Howlers (Chapman, 1929, p. 288), comparing in this respect with the range of the Squirrel Monkey. Insofar as the Capuchin may occur in second growth forest, a large area of the Island is open to him. However, the small growth that may shelter the smaller Squirrel Monkey will not answer the requirements of the heavier animal. The White-face appears to spend the night in the higher trees which may limit its range considerably.

Chapman's (1929, p. 285) description of this animal in its native haunts is unequalled: "Here is a master of his environment. Not even a bird passes through the forest with greater freedom than this quadruped. He skips and dances along the limbs and, without pausing a second to measure the distance or select a take-off or a landing-place, recklessly hurls himself through space and, with arms and legs widespread, crosses openings at least ten to twelve feet wide."

There are at least two ways of making a landing following a leap, for when there is a definite objective such as a branch or trunk, they jump to it with only the forearms extended grasping the objective with these, and taking up the force of the leap with the hind legs which are more or less drawn up for this purpose. The tail plays no role in this type of progression. If, on the other hand, the landing is made in a mass of vines or a dense tree-top no particular portion of which offers a firm purchase, they leap or drop, as the case may be, onto the mass, flying through the air with arms, legs and tail widely spread. When walking along large limbs, there is a great curvature in the back with the hump just behind the shoulders, half the tail extending in a line with the body, the distal half curled up. On smaller limbs the tail may be carried so that the curl of the end is about the support.

The longest jump witnessed was an extraordinary leap from a tall tree to a tree-top fully fifty feet below and twelve or fifteen feet away from the take-off. A group was feeding in a tall tree in full view from the laboratory. One young individual had gone out on a limb near the top and was feeding quietly when a large animal, probably a male, advanced along the same limb and charged the smaller animal. Without hesitation the latter leaped, although the nearest tree-top was fifty feet below. The flight, for so it appeared, was made with arms and legs outspread, and the landing was safe, for the animal moved off as though nothing unusual had occurred.

The temper these monkeys display toward each other, is utterly unlike the behavior of the other genera. There is a great deal of commotion and scolding and fighting. The most terrific screaming was heard one entire day (Dec. 16) from a band of these monkeys; the commotion stopped during a rain-storm, but began again immediately after. That evening the group moved into some trees where they were easily observed. Although the screams had stopped it was evident that peace had not been restored. One individual in particular appeared to be attempting to join the band, but was kept away. This individual, apparently a young male, attempted to climb one of the trees in which the group was settling down. But at each attempt, one of the band would charge him, in the face of which hostility the solitary one always retreated. Although many different members of the group took part in this antagonistic display, the most active was a female with a large baby which she was carrying astride her hips.

Although frequently heard, this constitutes the only observation by the writer of the behavior of a group during or following one of these "disagreements." Chapman (1929, p. 287) says that the family life of the Capuchins is "excitable and aggressive. On occasions, unrestricted warfare seems to prevail, and with squeals and screams every member of the band is either in pursuit or retreat. They perform incredible feats of agility and fly through the tree-tops so rapidly that I have never discovered the cause of the disturbance. Apparently it is tribal rather than individual, for suddenly there is absolute silence, the fight is off, and the animals disappear." That there may be a cause has been suggested above. That it is tribal instead of individual and that some of this behavior may be the result of the group being approached by a strange animal is borne out by the behavior of a group that visited the clearing from time to time, often approaching the cage where Jocko, a captive Capuchin, was kept. Toward him they showed very definite rage, scolding and shaking limbs, some of which they broke. Jocko did not appear alarmed by these outbursts, but acted very much subdued, pressing against the netting of his cage and calling gently. Sylvestri assured us that the wild monkeys would have killed Jocko had we released him, and their savage attitude was enough to convince one of the plausibility of this statement.

When on the move, the group calls back and forth using a hoarse cry not unlike that of a human imitating a crow. This cry is given two, three or four times, usually, but the series may be longer — or

a single call given. Males call more frequently than females. Sylvestri would give a call quite unlike the Capuchin's cry, but Jocko always replied, even though Sylvestri was a quarter of a mile distant. This same cry has several pitches and uses. There is another type of cry used as a warning note, and sometimes before rain. When Jocko uttered this note even the marmosets stopped their chattering complaint for a few moments.

These monkeys show great curiosity toward man, peering at an intruder and hurrying from limb to limb in order to secure a better view. If one sits quietly, they will come very close, even to within fifteen feet if they are called. Where they have been hunted they are much more difficult to approach. The note used under such conditions is aptly described by Chapman as an emphatic "chung!", or a questioning "how?" These notes are uttered singly and not in series as is so frequently the case when using the "location" call.

This great interest and the warning call are not reserved for man alone. On two occasions — both times early in the morning — a group was observed that was absorbed in watching some object on or near the ground. The only sounds uttered were the alarm notes of the monkeys. As the writer had been attracted to the area by the calling of ocelots and as a large cat was detected on one occasion, it was surmised that some such animal was the object of the attention from the monkeys. A. H. Schultz observed a group of *Cebus* that were very much excited and alarmed. This was at 11:45 A.M. Four hours later it was found that an ocelot had entered a trap near the same spot and that within that time the cat had trampled down an area about twenty-five feet in diameter, had scratched up a sapling, and finally wedged itself and the drag between the roots of a tree where they were finally found. The writer is inclined to believe that the cat was caught soon after Schultz left and that the alarm displayed by the monkeys was over the cat.

When a large group of Capuchins pass through the forest there is a more or less constant breaking off of dead limbs. "One, hurrying through the tree-tops, stopped, went back a few yards over his route, and with some little effort broke off a decayed limb and threw it to the ground. Whether it had annoyed him or whether he considered it unsafe for future passage, I do not know." (Chapman 1929, pp. 285-286). Some of the limbs that fall are deliberately broken by the monkeys but once in a while one breaks under the weight of an animal, precipitating him into the lower branches. Such stubs are eliminated systematically from trees which animals occupy fre-

quently, such as the large trees near the dock. Not that one would attribute any real system of removal to the animals, but rather that the habit of climbing about the trees before settling down for the night and during the desultory climb, pulling at every stub as they come to it, results in the elimination of unsound footholds.

That some limbs are broken deliberately is beyond question. Limbs may part under the vigorous shaking of an angry animal, but whether the intention was that or not cannot be determined. The animal may be on the limb shaken or may grasp a nearby limb to shake it. That the breaking off of the limb may be the object is indicated by the observation, in at least one case, of a Capuchin grasping a dead branch in both hands, breaking it off, and then throwing it away in the direction of the observer. This may have been merely the restless expression of the animal's nervousness when being scrutinized, or the venting of an impotent rage upon an unresisting object. Nevertheless, the act was so deliberate that one is inclined to ascribe intent to this monkey. On the other hand, the animals sometimes break the limb upon which they are sitting, as was seen several times, chiefly in balsa or other trees with weak, soft wood.

The Capuchin is more carnivorous than the other monkeys of the region — a fact reported by Belt (1888, p. 118) and Chapman (1929, p. 289). Leaves and bark are searched for insects of all kinds. Leaf stems are torn apart and the termites extracted, using teeth and hands to expose the insects. Birds, nestlings, and eggs, are eagerly sought, according to observers. Sylvestri stated that "mono cariblanco" destroyed the eggs of a crested guan (*Penelope cristata*) that had built her nest in a tall tree near the clearing. To these items might be added arboreal rodents and, possibly, bats. Dr. Herbert Clark of the Gorgas Memorial Laboratory told of moving some packing cases in the animal house at the laboratory. A mouse ran out from under one and started across the floor of a large cage containing Capuchins. A monkey pounced upon the mouse at once, catching very cleverly, then calmly eating it. Dr. Adolph Schultz reports seeing captive Capuchins eating raw beef.

But the bulk of the food is vegetable in origin. Fruits of several kinds are eaten including the fig which is so abundant during the onset of the rainy season; star-apple and mangabe are eaten, too. Leaves of several species of trees are eaten and that wastefully, for just a bite or two is taken before the whole twig is dropped. Chapman (1929, p. 289) describes the persistent attempts of one individual to break open a large green nut. In captivity all the table scraps as

well as bananas, lettuce, raisins, grapes, and bread were eaten. This monkey is truly omnivorous.

PANAMA SQUIRREL

Sciurus variegatoides helvcolus

This squirrel was observed in the second growth of comparatively small trees between Summit and Gamboa. From the young seen, one is led to believe that the breeding season is a few weeks earlier than that of the Canal Zone Squirrel. They live in nests which are compactly constructed of leaves and located in the tops of tall, slender trees. The nests here are usually placed on a limb at its juncture with the main stem against which the nest rests for additional support. There may be as many as one nest to every six acres in this region.

One young individual of this species that was seen was a very playful, friendly pet. He had been taken from a nest while very small and brought up in the house. He was not active after dusk.

CANAL ZONE SQUIRREL

Sciurus gerrardi morulus

The "Ardita" is the most frequently seen of the rodents for, while not as abundant as red squirrels in some northern woods, it is present in fair numbers. Instead of being most abundant in the deeper forest, it tends to occur where the mature forest lies near the second growth. In the region between Summit and Gamboa, where there is nothing but the smaller, second growth, this species does not occur, being replaced in this type of habitat by *S. variegatoides helvcolus*, a species that is absent from Barro Colorado Island.

The voice and action of these squirrels is strongly reminiscent of similar behavior on the part of the northern red squirrel. At times they are quite noisy, while at others they are silent. One day they dash off through the forest before they can be approached, the next they may approach the observer. What underlies this difference in behavior could not be determined. There may be a strong territorial sense which may explain those cases where the squirrel came down to scold the invader. Nor were individuals on nut trees, or groups similarly feeding, disturbed by an observer. Solitary squirrels not feeding, on the other hand, usually made off at a rapid rate.

When the fruit of the nut palm (*Scheelea zonensis*) was ripe, the squirrels had an abundant food supply easily available. They peel off the skin, and eat the pulp surrounding the nut, and may eat the nut at times. Doubtless their diet includes almendro as well as many other nuts and pods. In addition to nuts, fruit is eaten of which figs are the most important. Star-apple is eaten, too, also other fruit.

Although no stored food was located, a tendency toward storage was noticed. Individuals carrying food, either to a favorite dining site or some storage place were observed. Two half-grown squirrels were seen carrying green leaves up a tall tree; for what purpose could not be determined. Food is so abundant most of the year that storage appears to be unnecessary. Moreover, at least in the rainy season, there would be a high rate of spoilage. The writer has no record of any attacks on birds' nests.

Apparently there is little or no relation between food supply and numbers. In the Forest Preserve and along the road to Madden Dam, abundant food is available, but no squirrels were seen except near Aqua Buena, probably because the animal has been hunted for food. On Barro Colorado, they are nowhere over abundant and are, in fact, absent from many portions of the Island. What limits their numbers is not known, but it may be their many enemies, for there are many arboreal snakes as well as carnivores in the tropical forest.

All the females taken in June were pregnant and active spermatogenesis was going on in the testes of all males, so it is possible that the breeding season corresponds to the end of the dry season or some weeks later. The usual number of embryos is two. In one case both embryos were in the left horn of the uterus. One female contained three embryos near term. There are three pairs of mammae.

In traveling from place to place this squirrel makes skillful use of all lianas as well as branches. Because of the intricate net of vines, movement from tree to tree is easy in most cases, but when a leap is necessary the animal does not hesitate. When undisturbed, they may come to the ground and explore around as recorded of the Darien sub-species by Allen and Barbour (1923, p. 265), or move to another tree that might have been reached by traveling through the tops. One individual was surprised while feeding on a small tree in a patch of young second growth. As it dashed off through the tangle with the brightly colored tail streaming behind, it was difficult to decide, on the spur of the moment, whether the fugitive was a squirrel or a squirrel cuckoo.

CANAL ZONE PYGMY SQUIRREL

Microsciurus alfari venustus

All collectors agree that this small squirrel is difficult to secure either because of its rarity, or because it is difficult to see in forest cover. Although several were seen on the Island, only one which hung motionless for a moment was collected, for the others were too quick in making off. They may descend to the ground and escape by running over the forest floor against which they are difficult to see, or may dodge around a tree trunk and climb out of sight.

They show a decided preference for heavy forest and particularly the type of heavy forest where there is some undergrowth in the form of vines. In such places they are located with difficulty which leads to the idea that they are scarce. While not abundant, the numbers may be as great as the numbers of the larger squirrels. Both Carpenter and Mexico reported seeing them from time to time.

It is possible, too, that they are somewhat nocturnal, for on several occasions small mammals which were possibly this species were seen under the glare of the hunting lamp. That they were usually observed at the opening of a hole in a hollow tree or between buttresses of a tree suggests that they live in such places and that they were disturbed by the hunter in passing.

The only stomach examined contained material too finely divided to identify. That they occur in ivory-nut palm groves (Allen and Barbour, 1923, p. 365) might indicate that they eat these nuts. On the Island it is probable that they eat the nuts of *Scheelea zonensis* as well as other foods.

It is probable that the breeding season is in April, May and June, as in other squirrels, for the testes of one taken in June were active.

CANAL ZONE SPINY POCKET MOUSE

Heteromys zonalis

A pair of pocket mice was taken, one entering a trap set under a log near a small stream, the other in a trap set on a log over another stream, both in deep forest. Goldman (1920, p. 116) reports that this species "inhabits rocky slopes of heavily forested hills near the Atlantic coast."

There was nothing characteristic of the foods eaten in captivity, but the feces were distinctive, being black, compact, and smooth

with a high shine. The specimens were taken in January. The testes of the male were very large; the female showed signs of recent lactation. There are three pairs of mammae, one pectoral and two inguinal.

Spiny Pocket Mice are not uncommon in the forest about the Chilibrillo for hunters there were familiar with it, pointing out the cheek pouches at once.

PETER'S SPINY POCKET MOUSE

Liomys adspersus

A single specimen of this lighter-colored, shorter-tailed pocket mouse was secured. It was killed with a machete while attempting to escape from a heavy stand of grass in the Experimental Gardens. The cheeks contained a few seeds of Guinea grass of which there was a great abundance at this time of year (June 20). The specimen was considerably smaller than a young female collected by Goldman at Empire. This species is confined to the dryer, more open and grassy portions of the Zone. If it were not for the yearly burning over of the pastures of the Cattle Industry which destroys their cover this would be an abundant mammal for it appears to thrive in tall grass.

TALAMANCA RICE RAT

Oryzomys talamancae

Experience on Barro Colorado coincides with Goldman's statement (1920, p. 99) that this is one of the more abundant species in the forest. A series of twenty could be secured in a short time if the collector were there during the proper season. Specimens were collected under logs and rocks in the forest, chiefly along Lutz Trail, but mostly in the wood pile and under the cook's house. From the records it appears that this rice rat concentrates here during the rainy season and scatters through the forest during the dry season. Food may be a factor, but rain with the consequent filling of their holes by water is probably more important. Banana was the most effective bait and specimens were captured in many types of traps — from steel traps set for larger animals to small live traps.

Captive specimens built nests of grass in the darkest corner of the cage and were not active until well after dark. The food eaten was

the same as listed for the Pygmy Rice Rat with the addition of a few insects in the capture of which this rat is adept.

They have two breeding seasons, or, what is more likely, they breed the year around to judge from the following records of embryos: July 1, 12, 20, and Jan. 21; with four, four, four and three embryos respectively. Individuals of all ages were taken in a period of two months. There are one or more moults per year. They suffer greatly from ectoparasites.

On one occasion a Coati was observed eating a trapped specimen, and on another a Coati was surprised eating one it must have caught by its own effort. Hair, possibly of this species of rice rat, was found in Ocelot dung.

CORAZAL RICE RAT

Oryzomys tectus frontalis

A single specimen was captured in a small natural clearing created when several trees fell some two or three years previous. The animal entered a trap set three feet above the ground on a dead stub. This, with the structure of the feet, leads one to conjecture a scansorial habit, a fact in keeping with Goldman's statement (1920, p. 101) that he took them where grass and shrubbery were mingled. The testes were active (February 7).

PYGMY RICE RAT

Oryzomys fulvescens costaricensis

This is the smallest rodent taken on the Island. From December 10, 1930, to January 1, 1931, when trapping was discontinued, five were taken under and about the Shannon House which is located in the clearing. The only trap that was effective was the Sherman. Some individuals were kept caged for two months, then released.

The stomach of one killed during capture, contained a purplish fruit pulp, possibly the fruit of a nearby star-apple tree. In captivity, their diet consisted of corn, Bermuda grass (*Cynodon dactylon*) and fruits, chiefly banana.

Several nests were seen, all of which were made of fine grass, located on the surface of the ground under the edge of some rain-shedding object such as the eaves of a house or a piece of tin and board projecting from a steep bank. No nests were found under

logs or stumps or in places where the protection was less than a foot above the nest. The nest itself is made of grass, is globular in shape with a diameter of about four inches, and with but one simple chamber. Captive specimens, when given Bermuda grass, made a loose nest at once, building it more compactly the second night, for they are nocturnal. When a pair were placed together, each built a nest. Two were never seen occupying a nest together, either in captivity or under natural conditions. One individual was placed in a wire cage, one end of which was darkened by slipping an opened box over it. In a corner of this darkened retreat was a nest of grass that had been built by a Cane Rat (*Zygodontomys*). The next morning a new nest, composed of the materials in the cage, was found under the edge of the box, all of the grass from the former nest having been moved to the front of the box where there was more light. What advantages there are in such a location, aside from dryness, are difficult to state.

Savanna conditions, to which the species is supposed to be restricted (Goldman, 1920, p. 102), may be imitated in the clearing under the houses which are set high above the ground. As most specimens were captured on rainy nights, one is led to believe that rain does not inhibit their activity, regardless of their aversion to rain in selecting nesting sites.

This mouse in appearance, locomotion and habits reminds one of *Zapus*. The long tail and large eyes, as well as the habit of moving in bounds which average a foot in length, increase the resemblance. One individual, on being given cotton for nesting material, did as *Zapus* does, frequently becoming entangled and losing some of the tail. Individuals so injured show the same erratic movements in jumping as does the northern mouse following the loss of the end of its tail. Under the hunting lamp they appear very alert and try to escape by dashing from one bunch of grass to another, being perfectly still between dashes, but making long jumps when closely pressed. A female captured July 15, contained three 10 mm. embryos. There are two pairs of mammae, both inguinal.

While this rat was fairly abundant in the short grass about the laboratory clearing during June and July, 1929, and from November to March, 1930-1931, none were taken in other clearings; and none were trapped nor any nests seen near the laboratory in 1932. It is possible that the heavy rains of November, 1931, might have destroyed the nests and young, or the rats may have migrated.

So small a creature must have many enemies. Peccary, coati,

or any of the carnivores would certainly destroy any young found in nests; nor are the adults so large as to be immune from attack by tarantulas which are common.

CANAL ZONE CANE RAT

Zygodontomys cherriei ventriosus

The Cane Rat lives in the clearings, avoiding the forest and even dense second growth during the rainy season. On the island numbers were taken at the Miller range light clearing and about the laboratory and in the banana clearing, while several were taken in the Gardens at Summit. However, they are, apparently, absent from the new Island plantation which may be too new to have been occupied.

The nests are of grass and were located at the ends of short holes which enter banks or pass under banana or palm tree roots. Paths may radiate from these holes. Specimens were taken on banana and corn chiefly by placing a live trap under fallen grass or under the kitchen where they came to feed on rice, bread and so forth left by an Agouti.

Pregnant or nursing females were taken November, January, March and April. One captive specimen had two young, others contained three, three, and four embryos.

In addition to rice and bread they eat Bermuda grass, corn, fruit of all kinds, and seeds. Once the dry season set in, no more could be captured in their old haunts, which may be explained partly by the abundance of food, partly by migration to the forest.

They are nocturnal. One male was released in the laboratory where he lived for more than a month in spite of the fact there were openings through which escape would have been easy. The day was spent in the dark room in a box of excelsior, but shortly after nightfall he would come out for food. In moving he dashed from shadow to shadow, never remaining in the light, and only eating when the food was in shadow. This differs from the behavior of *Sigmodon* which is diurnal as well as nocturnal.

OECOMYS ENDERSI

The specimen, kindly described by Goldman (1933, pp. 525-526), was taken in the top of a tree that had fallen into a small, natural clearing on Barro Colorado Island. It is probable that the species

is scansorial, if not arboreal. The feces are black, as in *Heteromys*, roughly round, instead of elongately cylindrical, measuring 3.5 x 5 mm. There are four pairs of mammae—two pectoral, two inguinal. There were three embryos (February 12); two in the right horn, the anterior one of which was moribund.

BOQUERON COTTON RAT

Sigmodon hispidus chiriquensis

The Cotton Rat and the more abundant Cane Rat shared the clearings and both avoided the forest during the rainy season. The nesting habits are similar and they bear the same number of young.

The Cotton Rat is somewhat diurnal for specimens entered traps during the day. One was seen at 4:45 P.M., and allowed Donato to stroke its back with his hand!

This rodent suffers much from infestations of *Porocephalus* sp. which, according to E. W. Price who kindly determined them, are immature. They occur as adults in the lungs of snakes. The scrotum of one specimen gave the appearance of being full of these parasites.

BLACK RAT

Rattus rattus rattus

A few Black Rats were taken about the laboratory and kitchen, and one in the new plantation which is located at a great distance from the house. This agrees with Goldman's experience. Large numbers were taken in the Silver Quarters at Summit and Red Tank. In the greenhouses at the Gardens they did so much damage that poison had to be used to exterminate them. Specimens were secured also from the huts of Silver employees. It is probable that the following report of a native method of extermination applies to this rat, although it is possible that at times the infestation is by the Roof Rat (Krieger, 1926, p. 54):

"A peculiar practice is the Tule method of catching rats. As the houses are roofed with heavy thatch a large number of rats make it their dwelling place. On rat-catching day a representative group of men assembles at the house to be cleaned of rats and with clubs and long sticks climb on the roof and beat the thatch; as the rats descend the women and children assembled below kill them with clubs. The dead rats are then loaded in a boat and hauled out to sea and dumped overboard."

ROOF RAT

Rattus rattus alexandrinus

A single specimen was taken on the launch belonging to the Island. As food supplies are brought over in boat the rat might have been introduced in this manner. She lived here for some days before being caught. At Summit, two were taken in mango trees the fruit of which may be damaged considerably by this rat.

HOUSE MOUSE

Mus musculus musculus

Numbers of *Mus* were taken in the Silver Quarters at Summit, but House Mice were found nowhere else.

PORCUPINE

PUERCO PINNA

Cocndou rothschildi

The Porcupine is more abundant than one might suspect, for it is strictly nocturnal and largely arboreal. Nor is it very active even at night.

While felling trees for the laboratory clearing, several were dislodged from their hiding places. Carpenter located a specimen in a shallow burrow near Barbour Lathrop Trail, but was unable to dislodge it with a stick. Sylvestri brought in the skeleton of a recently killed individual which he found lying on the trail. The occurrence of the spines of the Porcupine in the skin of an Ocelot has been noted. This leads one to believe that, like its northern relative, it is attacked by the carnivores, possibly by mistake.

Of its food, Goldman (1920, p. 134) says, "One of these porcupines, purchased from a native hunter at Gatun, had its stomach distended with vegetable matter massed in two colors; a greenish part apparently leaves, and a white mass which had the appearance of fruit pulp. The hunter reported locating two in a tree by the light of a hunting lamp, but while he was securing one the other escaped."

Eight specimens were sent in by Mr. Shropshire's men and were kept in cages for about a month. The animals spent much of the day resting, sitting on their haunches and with the head turned in on the belly. At night they became quite restless endeavoring to escape. They feed freely on bananas both green and ripe.

Unlike the northern porcupines, the arboreal form is easy to handle. There is no switching of tail, which is not formidably armoured, nor any attempt to bite. The movements are not rapid although they can climb very well.

SPINY RAT

Proechimys semispinosus panamensis

This octodont, the macangúe of the natives, is the most abundant mammal in the moister, wooded portions of the Canal Zone. It inhabits the deep forests, living under logs, roots of trees, and in holes in the ground as well as in cut-over forest, brush lands, and in and about clearings and plantations. Its abundance may be judged from the fact that as many as five have been taken in one night by eight traps set about the clearing on the Island — an unusually high percentage for tropical trapping — as well as in the grassy areas near the edge of the lake and along streams.

Most of their activity is carried on at night. Of the numerous trips made after dark, on all but a few numbers of these individuals were encountered. Those in captivity would spend the day in some dark corner or under the litter, coming out to feed after dark. After a short time, however, they took to moving about during the daytime possibly because it was then that they were fed. They see well in bright light, but if undisturbed avoid it. None were seen before dark in the forest, but one sub-adult was observed near the laboratory attempting to enter a trap at 9:00 A.M. The trap was reset; at 5:00 P.M. the animal entered it. Another specimen was taken at dusk.

When exposed to direct sunlight for any length of time, the macangúe exhibits signs of distress and dies. If not removed from live traps before the sun is high only dead specimens are collected. Moreover, they consume much water, and appear to prefer damp, cool, hiding places during the day from which one might conclude that heat and dryness is a limiting factor in their distribution which is borne out by their absence from the drier portions of the Zone and Republic.

The food is as varied as the type of habitat occupied. Those taken about the lake had been eating Para grass (*Panicum barbinode*) and *P. grande*, while others taken in the plantation nearby had been feeding upon banana, sugar cane, corn and the fruit of *Physalis angulata*, another had eaten pineapple. In the forest almendro nuts are eaten, the covering without doubt and, possibly, the nut itself,

as well as the covering of the palm nut and fruits of all kinds. Stomachs examined contained star-apple, figs, and unidentified fruit pulp and plant debris. In captivity, a wide range of foods was readily taken including such foods as corn, rice, and bread. Nevertheless, grasses including Bermuda grass were always relished as additions to a fruit and grain diet.

The octodont is a singularly peaceful rodent. Individuals, newly caught, may be handled with safety if gently removed from the traps. Likewise, they may be picked up from the floor of the cage if not first driven into a corner. Usually they head into the corner and make no resistance, but may turn about and inflict a severe cut with the large incisor teeth, a fact soon learned by the man who cleaned the cages. Moreover, many may be kept together in a cage with no danger of fighting. They will crowd together in a nest, box, or corner and complain when others intrude; or scold when another attempts to rob them of their food but they do not fight. Even a young *Marmosa* was able to drive off a full-grown individual. Only one act of violence was observed and that toward a *Zygodontomys* which was occupying a corner into which a Spiny Rat chose to go. The smaller animal was seized with the teeth by the scruff of the neck and pulled out of the corner without any harm being done. The "scolding" sounds much like the noise made by guinea pigs. While the spines over the rump may be erected when the animal is frightened, this response is not frequent.

The Spiny Rat is not strictly terrestrial although most of the specimens were taken on the ground. Logs and overturned trees serve as highways to judge from numbers taken in such locations, some of which were ten feet above the ground. Where logs lie over small streams, they appear to form bridges over which Spiny Rats, *Marmosa*, *Heteromys*, and other small mammals pass. While about one hundred specimens were taken altogether of which approximately 20-25% had lost their tails, no specimens in this condition were trapped except on the ground. While the numbers are too small to be significant, they indicate that which will be explained later; namely, that the tailless individuals tend to avoid movements where the loss of balancing ability is noticeable as in running along small logs or climbing about them.

This leads to an interesting observation recorded by Allen and Chapman (1893, pp. 225-227) for *P. trinitatis* and quoted by Goldman (1920, p. 122) concerning the loss of the tail in this Panamanian species. The anatomical and histological basis of this loss in *P. s.*

panamensis is being studied and a report on the results as well as those of some experiments to determine how the tail may be lost will be made elsewhere. Here it may be said that such a loss is far from a handicap insofar as progression upon the ground is concerned. In fact, it may be of distinct advantage as far as speed is concerned for the tailless individuals are better adapted to terrestrial locomotion. The changes in locomotion as well as posture following the loss of the tail will be given with the other report. In this same connection may be mentioned the tendency toward syndactylism found in the hind feet of some specimens.

The reproductive cycle of the octodont differs from that of the rat, for while embryos were found from January to August, many adult females taken during that period were not pregnant nor did they become pregnant during several months of captivity under very natural conditions. Moreover, lactation is longer, lasting from March 13, to April 29 (forty-six days), in one case observed, and doubtless lasting longer. Two and three embryos are the usual number; no females containing more than three were examined. On March 11, a large female was isolated for observation. Two days later three young were born. While the writer did not see them at once, they were observed shortly after. They were fully furred, as was expected from the large, heavy embryos previously examined, and the eyelids were fully formed. They were very active, nimble and bright looking, and, while staying close to the female, were, nevertheless, rather independent. They made soft, whistling noises as they huddled about the female.

In eleven days they were tasting solid food, eating both bananas and dry corn during the consumption of which the action of the incisor teeth could be heard; but they continued to nurse. Two weeks after birth, grass and rice were added to the diet and while the young ate all the foods offered, they still nursed much of the time. At about this time the mother began scolding any young one that tried to take food away from her, nevertheless always giving up the food. The young were still nursing when observations were discontinued April 29. At that time they were not a quarter grown, had, in fact, grown very little since birth at which time the body was about two or two and a half inches in length.

After the young were about one month old, although still nursing, they did not always spend the day in the same corner of the nest as the mother. Specimens not very much larger wander into traps set under the houses about the laboratory clearing, indicating that

the family breaks up when the young are about two or two and a half months old. The growth from then on must be rapid as few half-grown young are taken.

Neither the pregnant female or any other captive specimen attempted to make a nest in the usual sense of the term, although given leaves, grass, and so forth. They usually hid under the litter without any systematic change in its arrangement. No attempts at digging or signs of digging were observed. Judging from this and from the condition of the young at birth, the writer is inclined to believe that no nest is made under natural conditions, but natural cavities and other protected places are used without modification. This belief was supported by observations of Spiny Rats living in hollow stumps, in holes dug by Armadilloes, and in rocky crevices.

The Panamanians insist that while they do not eat any form so low as this rat, the Colombians do. Goldman (1920, p. 122) states that they are eaten to some extent at Boca de Cupe, while a native of San Miguel Island assured me that the sub-species found there furnished an unfailing meat supply. This may well be for Barbour says: (Allen and Barbour, 1923, p. 264), "We tried them once when hard-pressed for food and then ate them regularly. The flesh is excellent."

Coati and *Didelphis* eat trapped specimens whenever they can get to them, so probably eat them in the wild whenever opportunity offers. The mobility of the young may be a distinct advantage in avoiding these enemies, although it is not, probably, a very effective method of foiling snakes. The first Spiny Rat identified on the Island was removed from the stomach of a *Boa imperator*. Doubtless everything large and quick enough to capture a rat is an enemy, but the worst enemy appears to be the Ocelot; this rodent forming, on Barro Colorado Island, the chief item in this cat's diet. A bot (*Cuterebra baeri*) was found in the left pectoral region of one individual. This bot is abundant on the Howler Monkey (Green and Shannon, 1926) but this constitutes a new host record.

By no means aquatic, the Spiny Rat swims well, striking out strongly with the front feet, using the hind feet irregularly, and tail not at all. Individuals living along the shore head in toward cover when disturbed, and cannot be induced to attempt escape by taking to the water. Moreover, if an individual falls in or is thrown in the shortest route to shore is taken. Nevertheless, they may cross small bodies of water voluntarily, particularly where grass-grown. This is borne out by the fact that it was found to be impossible to deplete

the supply of rats on a small islet which, under normal conditions, would not have supported more than three or four.

AGOUTI

Dasyprocta punctata isthmica

The Agouti is the most conspicuous rodent on Barro Colorado Island and may be classed as abundant. While its numbers do not compare with those of the Spiny Rat, they are nevertheless high.

While the smaller rodents are restricted to very definite habitats — *Zygodontomys*, *Sigmodon* and the Pygmy Rice Rat being confined to openings and brush land, and the arboreal rodents confined naturally to forests — the Agouti and Spiny Rat are found everywhere on the Island. That the Agouti is found in every type of habitat does not mean that its distribution on the Island is uniform; on the contrary, it is found in greater abundance in the heavily forested portions, particularly near ravines. In the very wildest portions of the Island, which happen to be fairly level, it is not so abundant. This may be because of the presence of enemies as well as the flatness of the ground and the height of the water table, which would discourage burrowing. Neither is this species particularly common in the smaller, second growth forest, where it is probable its numbers are limited by the available food supply. In other parts of the Canal Zone the Agouti is a rare animal because the tastiness of its flesh has led to a great reduction of its numbers through the activity of hunters and the clearing of the land.

The Agouti has been described as a small animal with a rabbit's head on a pig's body. When one is seen trotting along the forest floor, one is struck by the accuracy of this description. The Agouti is strictly terrestrial and is very well adapted to locomotion on the ground. There are several gaits used by the animal. When wandering aimlessly over the forest floor, the animal walks, using a gait similar to that of a horse, and is digitigrade. At other times, the animal breaks into a definite trot, but when surprised or attacked, the powerful hind legs are brought into play, and the gait becomes a gallop in which the hind legs and forelegs are used alternately — the forelegs held close together, and at each bound the hind legs passing around them to be planted in front. Most of the drive in this type of progression comes from the powerful muscles of the hind legs and back. While not being exactly the gait of the rabbit, for

there is not the disparity in the size of the fore and hind limbs, the use of the hind legs is strongly suggestive of the rabbit's as the hind feet approach the plantar position — all of which is most noticeable when the Agouti chooses to dash off uphill. Another typical pose in which the Agouti is seen is as it pauses, fore foot upraised, before it leaves cover, or stops to test the breeze. Then the forefoot is put down carefully and silently and the animal moves a few feet and then again "freezes," forepaw upraised.

Correlated, possibly, with the structure of the hind leg, is the posture assumed by an Agouti when alert or feeding. The body is held erect while the entire length of the tarsi rest on the ground, giving the animal a wide base of support, and leaving the forepaws free to grasp or manipulate food material. Usually, the haunches do not come in contact with the ground. The stability of this position becomes evident when the animal is observed closely, for it rocks back and forth with the claws alternately off and on the ground. The body is upright, the weight being centered near calcaneus. This is well illustrated by a photograph by Chapman (1931, p. 351). From this position the animal is able to start off in almost any direction and to attain great speed at once from the initial powerful thrust of the hindlegs. This may be of distinct advantage in escaping the charge of some enemies such as the carnivores. The quick getaway, the baffling change in direction, and the astounding ability displayed in dodging about obstacles depend upon the employment of the powerful hindlegs.

When, in their journeys, water is encountered, the Agouti does not hesitate to swim. Sylvestri observed one swimming voluntarily from Orchid Island to De Lessup's Island. He said that while the Agouti is about as good a swimmer as the Paca, it does not dive as does the larger species. The harsh and scanty vegetation of De Lessup's Island is not sufficient to support the Agouti population, so the home range of such animals as live there must be extended to include an area of more favorable growth, which can be done only by swimming.

The native name for the animal is "ñequi," which is, in all probability, derived from the sound the animal makes when surprised. Sometimes the Agouti remains still when approached, seeking, possibly to avoid detection by "freezing." When one approaches still closer, or when one actually surprises the animal, it leaps off shrieking "Ñequi! ñequi!" The movement is so abrupt, and the cry so startling that it never fails to surprise. Upon discovering it is not being pursued, it moves off quietly, grumbling to itself. When thus surprised,

the long hair over the rump is erected, but returns to its normal position as soon as the animal regains composure. It is almost inconceivable that such a loud and ferocious note could issue from the throat of so small and timid an animal. Whether this cry is for the purpose of warning or is merely the expression of fright cannot be stated. This startling cry is by no means the only note. There is also a shriek of pain and a soft, whimpering "conversational" tone used between the mother and young.

This Agouti lives in burrows, frequently along steep banks, a fact noted by Goldman (1920, p. 127). In addition to burrows located in such places, there are many under roots of which the Agouti takes advantage in the construction of its burrows. The writer watched the construction of several burrows of this type, the animal digging down under a large surface root, following the larger roots when encountered, but severing the smaller ones with its teeth. This makes a very intricate type of burrow, and one which it is all but impossible to dig out. Trees standing on higher ground are chosen probably to avoid the effects of heavy rains. One animal may be digging as many as three burrows at a time. At the far end of the burrow is a nest chamber the floor of which is scantily covered with dry leaves and sometimes twigs. This bedding is added to from time to time. The nest and burrow are free from excreta. Trails are formed by the Agouti leading from the burrow into the undergrowth or forest. "In places their paths up the steep faces of cliffs have been used so long that they are worn deeply into the surface of the rather soft limestone." (Goldman, 1920, p. 127). Such trails offer a safe and easy retreat. Frequently, when animals are disturbed while feeding in the forest, they rush over the edge of a nearby bank to disappear into their burrows. The speed which they make on such occasions is quite astounding. Also, they are extremely agile and sure-footed.

The home range of the Agouti is rather restricted. Under normal conditions, they remain within a radius of three hundred yards of their burrows, although in time of food scarcity, they may undertake long journeys to reach favorite food trees. It is also probable that even longer journeys are made in response to the mating urge.

The Agouti is a more or less unsocial rodent, each burrow being occupied, as far as the writer's observations go, by a single animal. In addition to being a solitary animal, the Agouti is quite pugnacious towards others of the same species. This antagonism appears to be as great between male and female as between individuals of the same

sex. The home range of an individual may therefore be dependent not only upon food supply but also upon the range of other Agoutis. From this it must not be understood that Agoutis are never seen together, for frequently they feed peaceably under almendro and fig trees. On the other hand, only once has the writer observed Agoutis together away from such feeding places without noticing the very definitely hostile attitude towards each other — even between members of the opposite sex, and on this occasion the two had come down to the lake to drink. Very few Agoutis are found that do not bear the characteristic scars made by the claws of others of their own species.

Where prosecuted, as in the Canal Zone, the Agouti is nocturnal. On the Island, Agoutis were seen at all hours. As a matter of fact, not a single one was seen during the course of night hunting, although they were abundant in the early morning and at dusk in the same territory. This condition differs from that found in its relative, the Paca, which is nocturnal everywhere. A female that lived about the clearing usually returned to her nest shortly after dusk unless she was hungry, in which event she would come at any hour if she were called. The day is probably spent resting in the burrow; the tame female would spend the day lying on the cool earth under the cook house. Also, while she was not afraid of light, she preferred the shadows, choosing to move rapidly from shadow to shadow even when the sky was overcast — a fact that made photography difficult. As long as there was light she would not linger under the open sky.

The food of the Agouti consists of many succulent plants growing on the forest floor. In search of this food they wander about sniffing and nibbling here and there. The plants eaten are chiefly herbaceous, representing many species. About the clearing some Bermuda grass was consumed. The herbaceous diet is supplemented by both fruit and nuts. Being terrestrial the Agouti must depend upon whatever drops to the ground, so only such abundant fruits as figs are available. Similarly, the outer husk of the palm nut is eaten, while both the fleshy covering and kernel of the almendro form an important element in their diet during the season of the year when these ripen.

A female without lower incisor teeth and but one upper incisor was very much dependent upon the laboratory for food. She lived about the place for well over a year, so ample opportunity was afforded to observe her choice of food. She ate bananas, papaya, ships biscuits, bread, lettuce, and partially boiled rice. Dry corn she would accept but did not eat except during lactation. This diet kept her in ex-

cellent condition. Once she was observed gnawing at some cooked gristle and, of course, she ate the placentae after delivery. (Enders, 1931, p. 395.)

When she had eaten her fill, food was carried off and buried in the ground. With a few quick strokes of the forepaws, a small hole is excavated, the food placed in it, and then pressed down with the paws, some soil placed over it and tramped down, then more soil added, leaving few tell-tale marks. The whole performance is remarkably dextrous for the Agouti is well equipped for digging. When replacing the soil it is pulled to the hole with the forepaws rotating outward and the strokes are deft and sure as those of a cat playing with a ball held between the forepaws. No discrimination as to the character of the food buried was shown; soft, easily spoiled food being buried along with less perishable food. So much food was offered that there was no necessity to return to stored food. If such a habit exists in the race, and nuts and fruits are carried off and buried in times of abundance, the Agouti may play an important role in perpetuating such trees as the almendro. Small pieces of food such as star-apple, almendro nuts and so forth, are picked up in the forepaws by which they are manipulated while the edible portions are cut off by the strong incisors.

Reference has been made before to the small home range and the pugnacity of the Agouti. Breeding behavior leads to considerable wandering about and to much fighting. Thus, a male was observed pursuing the laboratory female on November 16 at 2:00 p.m. She may have been pregnant at the time. The day after parturition, she went into the forest and was heard to squeal, emerging with a deep gash in the middle of her back. Whether or not it had been inflicted by a male Agouti was not determined, but, as most rodents breed soon after parturition, it is not unlikely that she had gone into the forest for this purpose. Moreover, Donato said that he saw her with a male Agouti, and that they fight thus during oestrus. Twenty-four days after parturition, she was seen to copulate. The fighting and noise that preceded intramission attracted the attention of all those about the laboratory. When observed a year later, this female was scratched up, for she had been fighting again. It would appear that many of the scars found on both sexes are the result of struggles attending mating. At no other time do they appear to consort together.

If the female referred to did copulate November 16, and it was a fertile copulation, the gestation period is 35 days, for parturition took

place December 30. This is not likely, for the gestation period in other similar rodents is approximately nine weeks, and, as the young are very well developed when born, there is little reason to expect a shorter period.

The usual number of young is two. The natives say that one is male, the other female; but observations made on pregnant uteri fail to bear out this contention. One uterus containing four embryos was seen. There are four pairs of mammae of which the two posterior pairs are better developed. Apparently there is no fixed breeding season, as pregnant and non-gravid females were secured during July and August and also in November and December, the only months when any were collected.

The young are well developed when born. Embryos of 135 mm. have well developed claws and a full coat of hair. In one case, when parturition was observed (Enders, 1931), the young attempted to nurse before both had had the umbilical cord severed; they also wandered a considerable distance from the mother, exploring about the nest area. The hair is well developed, showing the characteristic Agouti pattern and being longer over the rump. The eyelids are completely formed and the young walk and run about with ease. The male weighed 211 grams. They nibbled at the leaves which composed the nest within an hour after birth. When the mother "froze," they did the same, and when picked up and replaced, they maintained the position for a few moments.

About three hours after birth the mother and young left the nest, going to the forest, but returned in three hours. Two days later they occupied a burrow that had been dug a few days before parturition. This desertion of what had been the home of the mother for many weeks might have been the result of the presence of the writer, but why had a new burrow been prepared before this disturbance?

Had it been meant for the birthplace, but not finished in time, or does the Agouti usually move the young to another place? After the change she continued to enlarge the burrow for some days, then again moved — this time to the old nest site; then into still another newly excavated burrow on the hillside near the laboratory. This second move was preceded by very fierce fighting with another Agouti which the writer ascribed to breeding behavior but which may have been over territorial rights.

The female was much more difficult to watch after this, evidently avoiding going directly to the burrow; and she did not come out until dusk or dark. When she returned to her burrow, one young

one would come out to meet her. At this time, four days after birth, the young nibbled at various types of food and ate banana. They were very nimble. Shortly afterward the male disappeared and while the female young one stayed about for several months she never became as friendly as the mother.

The anal glands of the Agouti have a characteristic odor which is very noticeable when one is being skinned. This odor does not affect the flesh sufficiently to detract from its palatability. On several occasions Agouti were seen to evert the openings of these glands, rubbing the anal region against a root or tree. Also, when badly frightened these glands become active.

Man has reduced the Agouti population wherever he goes for the flesh is a valuable food. The Indian or negro may lie in wait near a hole for an opportunity to bag an animal but most hunters "shine" them. They are difficult or impossible to trap.

On Barro Colorado Island their greatest enemies are the cats and snakes, for the Agouti furnished much food for the cats as is demonstrated by the amount of their hair found in the dung. The relationship to snakes is difficult to understand. The tame female about the laboratory would react either to a Boa or the shed skin. On spying the snake she would approach it striking the ground with her hind legs as she advanced. The anal glands were protruded so that they touched the ground at each thump. The whole hind quarters were raised off the ground and the feet from os calcaneus to the claws, brought down with considerable force. This was or was not followed by scratching movements in which the hind feet were used alternately.

A *Boa imperator* was placed in one of the outdoor cages. When the Agouti became aware of its presence she approached it with the usual thumping and scratching. She came up to the cage and went on with the performance for several minutes before the boa struck at her. The intervening wire netting stopped the stroke in midair, but the Agouti whirled about, dashed away for a few feet, then turned about and repeated the performance. This type of behavior occurred day after day. After seven weeks the boa was released because it would not eat in captivity. Three days later the Agouti disappeared and was not seen again. One wonders at the significance, if any, of this in the light of the reaction of the Agouti to snakes.

Ectoparasites are abundant on the Agouti, both ticks and fleas being found. During the rainy season, patches of red ticks are found on the edges of the ears as well as the neck, and in the pectoral and inguinal regions, causing the animals to do considerable scratching.

Hunters insist that Agouti may be called with a whistle. The call is made in various ways, but all such contrivances give a sharp note that is made to "tremolo" by tonguing or by using a leaf. While the custom is wide-spread, calling was not attempted in my presence.

PACA

Cuniculus paca virgatus

Few pacas have been observed on the Island for they are strictly nocturnal, nor do they attract notice by uttering a loud cry when disturbed as does the Agouti. They were seen in the wild pineapple (*Ananas magdalenae*) on Armour Trail, on Wheeler Trail, and about the clearing, but chiefly along the shores of the lake where they were easily located from a cayuca by their noisy movements about the forest floor, and by the reflection of the light of the hunting lamp in their eyes.

The burrows in which they live are located in banks or on steep slopes, some of them communicating in the back with an opening at the top that is some distance from the edge of the quebrado. Carpenter called my attention to the fact that the openings of many Paca burrows were plugged with leaves. The purpose of this is not known, but it results in keeping out mosquitoes which otherwise swarm in such places. Such burrows were found along the bank of the stream west of the clearing, under the rocks in the old plantation and along many of the slopes all over the more densely forested portions of the Island. The fact that it is the rougher portions that are forest covered is thought to be more of a factor than the density of the forest for many burrows are dug in cleared slopes.

Paca is scarce in other parts of the Canal Zone, for hunters receive as much as forty cents a pound for undressed carcasses, so it is much hunted. In the Republic, the hunter uses small dogs and a hunting lamp which is a deadly combination, for when a Paca is started, its panic is so great that it seldom reaches its burrow. Those that are successful in reaching their burrows are driven out by small dogs. When not approached too closely, the Paca does not appear to fear the hunting lamp. When the forest floor is covered with dry leaves they move very noisily, so are easy to locate. But upon taking fright they run swiftly and quietly, quickly fading from sight. This is not so if disturbed during the day, for then they dash off blindly. One was driven out of a burrow in the new plantation; without hesitation

it rushed to the lake, dove, and disappeared. They enter the water voluntarily as is shown by their depredations in the new plantation, to reach which it is necessary to swim around the end of the animal-proof-fence which, crossing the neck of land, separates it from the rest of the Island. Sylvestri reported that Paca swim and dive with ease.

In the forest, roots are dug and fallen fruit eaten. In the plantation, they destroyed yams, cassava, and sugar cane, as well as other vegetables, and were the cause of bitter complaint on the part of Sylvestri. Among their favorite foods is the avocado. Enlarging upon this preference for the alligator pear, the natives say that the best way to hunt the Paca is to fill the pocket with small stones, take gun and electric torch, and climb into an avocado tree the fruits of which are ripe. After a suitable interval of time, a stone is dropped; the Paca hears the impact and taking it for the fall of a fruit hastens to the spot. All that the hunter needs to do is to flash his light upon the hungry animal and shoot it. Regardless of the truth of this recital, one has but to watch the avocado trees on the Island to be convinced that a fallen fruit does not remain undisturbed for long.

FOREST RABBIT — "MULITA"

Sylvilagus gabbi gabbi

Donato insisted that there were no "Mulita" upon the Island; none have been recorded thus far. The only specimens examined alive were three captives; one taken on the savanna near Panama, another at Las Cascades Plantation, and another which was run down in the tall grass in the Experimental Gardens. Others were seen at the Plantation, where they were abundant, doing considerable damage to the young rubber seedlings. At dusk they came out of the shrubby, dense growth that has sprung up since the Plantation was abandoned to feed about the clearing. A lactating female was taken March 25, and two immature specimens two months later. The pelage and color are variable.

COLLARED PECCARY — "ZAJINO OR ZAGINO"

Pecari angulatus bangsi

". . . The Collared Peccary, or Zagino next to the Coati, is the most common of the larger mammals on Barro Colorado. It is frequently encountered in bands of from three or four to twenty, but the usual number is about eight to twelve." (Chapman, 1929,

pp. 209-210). Solitary individuals, both male and female, are seen from time to time.

Collared Peccary and peccary signs are abundant all over the Island, but they are more abundant in certain localities than in others, and the favored localities vary with the food supply and season. This peccary, as distinguished from the larger White-lipped Peccary, is more an animal of the undergrowth than the open forest floor. Not that it does not occur in open forest but it is more abundant where there is dense undergrowth, and it is through these thickets that the peccary make their trails. Thus, the greatest numbers of peccary are found where the forest canopy is not too dense. In the more remote portions of the Zone, peccary are fairly abundant, but they are rare or absent over most of the area. They are rare because they are hunted for food and because their destructiveness in gardens has resulted in their ruthless extermination.

The trails of the Collared Peccary lead not only through the bushy tangles of the shrubby vegetation, but everywhere. They are very conspicuous along the sides of ravines where they angle down the bank following an easy grade instead of going straight down and then up again. While the peccary is nimble enough, steep slopes are avoided for the clay is hard and becomes very slippery when wet.

The man-made trails are not used much by this species, although they cross them without hesitation (Chapman, 1929, p. 212). This is consistent with their habit of keeping to cover and to their own trails. Where the wild pineapple is too dense to penetrate, a man-made trail is sometimes used until a break offers an opening through which a peccary trail leads off again.

The trail of the peccary is narrow for they travel in single file when moving from one place to another. This habit results in well defined paths being worn particularly between feeding grounds and resting places and wallows. Such trails are easily recognized by the tracks as well as by their size. Final proof may be obtained by smelling twigs and branches where they have rubbed over the backs of passing peccary, for each contact with the musk gland leaves this characteristic odor.

When these trails pass through thickets they are too narrow and not high enough for a man to follow except by crawling along on the stomach, but this is well worthwhile for these trails reward the observer as well as the trapper for along them move many of the lesser mammals such as the Coati, octodonts, and several genera of marsupials.

Thus they constitute the highways through patches that otherwise would be difficult for small mammals to penetrate. This is particularly true of the trails through the dense growths of wild pineapple. These trails are not feeding trails but are the highways along which the peccary move. In feeding along the forest floor the band may spread out, rooting here and there as they go, and doing a very thorough piece of work to judge by the signs left in their path. They feed much as a band of hogs. But when moving from one place to another the band moves in more or less single file which, if the region is much visited, soon makes a trail. Even in open forest, this tendency to go single file is well marked.

"They are omnivorous, feeding on everything edible, from roots, fruits, nuts, and other vegetable products to reptiles and any other available animals. They are specially numerous in many tropical forests where wild figs, nut palms, and other fruit-bearing trees provide abundant food. In the arid northern part of their range, dense thickets of cactus and mesquite afford both food and shelter. Their presence in a locality is often indicated by the rooted-up soil where they have been feeding." (Nelson, 1918.) "In regions where they are little disturbed they have their regular feeding stations, called comederos, under fruit trees but where they are much hunted they quickly abandon this habit." (Allen and Barbour, 1923.)

Food varies with the season and the peccary shift with the changing supply. When almendro nuts are ripe, the cracked nuts are found under every tree and the trails of the peccary lead from resting place to tree, and from tree to tree. In eating the nuts the peccary "cracks the nut along the lateral seam that divides it into halves, a tribute to the hardness of his teeth and the power of his jaws. He also eats it unbroken, doubtless for what remains of its outer covering, since it passes through the alimentary canal entire. These animals, therefore, must play an effective part in the distribution of the almendro nuts and hence in the perpetuation of the species." (Chapman, 1931, pp. 349-350.) In addition to this nut the peccary eats whatever fruit, root, or bulb is available at this season. Star-apples are eaten as are succulent foods of various kinds to judge from an examination of the feces during this period.

With the passing of the almendro season, figs of many species furnish the chief item of diet until with the advancing rainy season their fruiting period closes. After the fig crop is consumed, the palm nut, *Scheelea zonensis*, furnishes the bulk of concentrated food. The outer covering of these nuts is eaten and by the time the next dry

season rolls around, few have escaped the attention of hungry animals. This food supply lasts for many months and although the fallen nuts may not be very choice food toward the end of the nut season, they furnish, nevertheless, an unfailing food supply which is deserted only with the ripening of the almendro. Probably the peccary assists in the dissemination of this palm much as it does with almendro.

Sylvestri showed Carpenter a tree called "Carano ediendo" from which the bark had been gnawed and the gummy exudate that collected eaten, and assured him that it was the work of this peccary. Standley (1928, p. 224) says that there is a tree *Protium asperum*, called "carano," "from the trunk of which exude large amounts of a liquid resin of a peculiar strong agreeable odor," so the exudate may be natural although the flow may be increased by the attention from the peccary. Usually the Collared Peccary does not eat the seeds of the Monkey's Comb (*Apeiba aspera*), but when the almendro crop failed in 1932 they fed on *Apeiba* to a great extent. Standley (1928, p. 203) says of Cativo, *Prioria copaifera*, "Peccaries are said to be fond of the fallen pods." If so, the animals must be hard pressed for food, for no signs of any feeding by peccary were found at any time in spite of the abundance both of the tree and its large fruits. Chapman (1931, p. 350) also notes that this fruit is little, if at all, eaten by animals. Membrillo (*Gustavia superba*) is another fruit eaten in season. Peccary are "also attracted by the fresh growth of grass and sprouts in the clearing." (Chapman, 1929, p. 75.) "They feed on fresh growth of various plants and shrubs, often holding them down with their feet." (p. 210.)

Chapman (1929, p. 212) believes that this peccary is "chiefly, if not wholly, diurnal." They are most active during the early morning and in the late afternoon, a fact noted by Mearns (1907, p. 167) as well as by Chapman (1929, p. 210), spending the intervening hours lying under cover or in wallows of dust or mud. However, frequent observations indicate that feeding may be carried on at all hours of the day and night. Statements to the contrary notwithstanding, the peccary is easy to hunt at night for the eyes reflect light with a characteristic greenish tinge and are very conspicuous. When food is scarce or the animals are much hunted, most of the feeding may be done at night as hunters of experience verify. Nevertheless, where undisturbed, the animal is a lover of light. A captive specimen was willing to play at all hours of the day or night in marked contrast to deer and monkeys.

On moonlight nights peccary do much more moving about than

during the dark of the moon. In this they do not differ much from some other animals. When the moon was full a pet peccary spent much of the night pushing his feeding pan about the pen, but neglected this play when nights were dark.

How is the day spent? Field notes reveal that most of the bands observed up to 10:00 A.M. were feeding or moving to or from feeding grounds. From ten o'clock on, fewer bands are on the move while more are resting or wallowing until at 4:00 P.M. the bands begin again to move and feed. How late feeding is carried on has not been determined but two bands were seen feeding at midnight when the forest was very dark for it was in the dark of the moon. Resting bands have been observed from 7:30 P.M. on to midnight.

Of the opinions of how the peccary spends the night Roosevelt's statement (1893, p. 351) reflects the usual belief: "At night," he says, "they sometimes lay in the thickest cover, but always where possible, preferred to house in a cave or big hollow log; one invariably remaining as a sentinel close to the mouth, looking out. If this sentinel were shot, another would almost certainly take his place." Seton (1928, p. 731) states that he sleeps in some sort of den, and habitually takes refuge in a hole. Of this habit of hiding in caves, or logs, or holes the writer found no evidence on Barro Colorado, nor did the bands observed resting at night lie in the deepest thickets. If logs were so occupied the peccary odor would linger about them and feces would be found, for the peccary is much like the domestic hog in his dropping of dung anywhere regardless of the other uses to which the spot is put. Many hollow logs were thoroughly examined without a single one showing peccary sign. Although they root and wallow in the soft earth around the upturned roots of fallen trees, none were seen in such a location at night, nor were there signs of such occupancy. Such bands as were seen were lying under trees, chiefly palm trees, the leaves of which offered considerable shelter. The animals were lying about in groups of two and three, alert, and facing in all directions; no sentinel was seen. On taking alarm, the band would rise and move off slowly and silently.

All who have any acquaintance with the peccary speak of the musk gland which is located on the dorsal midline anterior to the pelvic girdle. The odor is not offensive and when not too concentrated is actually rather pleasant, in distinct contrast to the stench of the White-lipped Peccary, a fact recorded by Azara (1801).

Just what role this gland plays in the life of the peccary it is impossible to state. In both sexes it is well developed. The secretion

is brown to light brown, clear, and as fluid as light engine oil. It is not much affected by soap; alcohol dissolves much of it, and ether all of it. Musk is not secreted at all times, and secretion is increased by any excitement, pleasurable or otherwise. Nevertheless, there is always a distinct aura of musk about a band except, possibly, when they are resting and wallowing. Grant (1916, p. 387), says that "habitually, the boars rub their backs on low limbs to leave their trade mark behind, and thus mark out their range." The fact that the branches overhanging the trails bear evidence of this rubbing may or may not be so interpreted. Musking, under these circumstances, the writer is convinced, is accidental. On the other hand a young boar, kept at the Gorgas Memorial Laboratory, was observed, on his release from his quarters, to go up to a corner of a building, sniff the wall, then turn and rub his musk gland against the corner, a performance strongly reminiscent of a somewhat similar habit of the canine tribe. It is also true that certain trees in the forest are so much rubbed as to remove the rough bark, but this may be for the purpose of scratching, for ectoparasites are a source of considerable irritation.

Another pet peccary would play with the writer for a short time, then come up to have his head and jowls scratched, a proceeding from which he appeared to derive some satisfaction, then he would attempt to rub his musk gland against my knees, and on being held off would make a similar attempt to make contact with the hands that were holding him. If the fingers were run lightly around the area, he would stand comparatively still, the gland secreting actively the while. Thus the area about the gland may be an erotogenous area responding to touch.

When suddenly alarmed, there may be a secretion of musk, but, when the bands move off quietly, there is little or no, possibly less, odor than when feeding. The view expressed above that the gland is inactive while resting and wallowing is based on about fifteen observations, but is not to be taken too dogmatically.

The literature is full of references to the fact that the musk gland must be removed at once after killing the animal if the flesh is to be eaten. In two cases the writer killed sows and left the gland intact while the animals were carried over a mile, weighed, and skinned — an elapsed time in one case of two and a half hours. But the meat was not tainted; it was like dry and stringy pork, but there was no odor. How the flesh of sows in oestrus, or boars would be affected by the failure to remove the gland is another question. To the

delight of the Panamanian who helped in cutting up the carcasses there was a considerable amount of fat on the shoulders and in the omentum. The natives consider the animal very good eating, a fact that has much to do with the depletion of herds in settled districts.

A female containing two fetuses, 48 mm. in crown-rump length was shot July 16, (Wislocki, 1931) while a younger female killed December 1, was neither pregnant nor were her ovaries active. Young peccary the size of Agouti were seen in late January (Chapman, 1929, p. 192), and February 2; while a half-grown pet at the Laboratory in the period from July to the next February passed from a half-grown individual to one of about adult stature. It is possible that the young are born at any time of the year as Seton (1929, p. 730) states, but from observations on the Island, one is inclined to believe that most of the young are dropped early in the year for no young ones are reported at any other time. The young grow rapidly but judging from the development attained by one pet boar and the fact that no ovarian activity had taken place in a female probably a year old, they may not bear young until the second year. Azara (1801, p. 119) says the peccary breeds but once a year and has two young at most. This fits in with the observed facts on Barro Colorado.

A band, one member of which was the size of an Agouti, was approached as it was feeding. When they became aware of the approach, they retreated quietly to a nearby thicket leaving the young one alone and out in the open. The entire band lingered along the edge of the thicket showing neither marked hostility nor any inclination to bolt, so the desire to capture and examine the young one had to be suppressed. For a few moments the baby stood "frozen," then dashed into the thicket and moved off into the forest with the waiting band.

Just how a band or individual will behave under given conditions is difficult to predict. A large band may bolt with loud surprised grunts, or may fade away silently, or remain to stare for a time — even advancing toward the disturber before retreating. Solitary individuals vary as much in their behavior, but solitary boars are more inclined to bristle up, click their jaws and give a challenging grunt or two before bolting. Undoubtedly the degree of surprise as well as the availability of avenues of escape, and the proximity of the disturber, influence the reactions. If the band is down wind they usually move off quietly, moving so cautiously that only a few glimpses of retreating shapes make an identification possible, but if the breeze has not borne the odor toward the band, they may bolt

in such disorder as to divide. If they cannot be sure of being approached, they may stand very still and alert, staring at the point from which the suspected sound or odor comes with eyes unblinking, ears cocked, and nose busy trying to catch a telltale current of air; for the nose is most acute, hearing is less acute, while sight is rather poor. This sharpness of nose is well illustrated by the following passage from Chapman (1929, p. 210-211):

"At the end of January, 1927, for five successive days, six Collared Peccaries fed on the hillside in the clearing immediately below and east of the laboratory. They fed on fresh growth of various plants and shrubs, often holding them down with their feet. They were there from one to two hours in the morning and again late in the afternoon. If I approached them quietly from the leeward, they permitted me to advance to within forty feet and watch them indefinitely without showing any evidence that they were aware of my presence. If, using the same caution, I advanced toward them from the windward they retreated to the forest when I was still distant some sixty feet.

While sitting quietly on the upper steps of Redwood House I have seen a Peccary, feeding, come slowly from the forest into the clearing, where it soon sniffed the air. It gave no sign of seeing me; its suspicions were aroused not by what it saw but by what it smelled and it retraced its steps to the forest.

When approaching Peccaries from the leeward, their presence is sometimes betrayed by an unmistakable, characteristic musty odor. On one such occasion, I encountered a band of ten or twelve, including a mother with a young one about a foot in length. In evident response to a warning note, the little one remained motionless at a distance of about thirty feet while its mother, dorsal bristles erect, approached to within fifteen feet of me, first from the right then from the left, apparently trying to get my scent. Then it gave the alarm and with its offspring scampered off through the forest."

A band encountered on the trail was sent scurrying in all directions when an armful of metal traps was dropped with a clangor.

On several occasions bands were observed in their wallows. These were located in the forest, away from streams, where the soil was loose, either on gentle slopes or where the roots of an upturned tree had loosened the surrounding soil. Some wallows were muddy but most of them were dry. These wallows were used during the heat of the day, the animals lying about singly or in twos and threes.

The coat of the Collared Peccary is sleek and glossy in spite of its

sparseness and is kept in good condition. There are ectoparasites, chiefly ticks. The writer has observed neither fleas nor warbles. This clean appearance is very different from the straggly, mangy look of the larger genus.

The larger cats kill adult peccary without doubt. The small individuals might be eaten by the Boa, but the most important enemy is man who, in a region where both proteins and fats are scarce or expensive, hunts relentlessly.

The voice of this peccary has a pig-like quality. When feeding they may squeal and push much as do domestic pigs, but at other times they may be silent. When wallowing they give vent to little grunts that one is tempted to interpret as grunts of satisfaction! There is a "woof" of surprise, a barking challenge to a disturber, and a high squeal of precipitate flight. The surprised "woof" may be a single note sounded as the animal turns to face the direction from which danger threatens, or it may be uttered at every bound as the animals scatter. Also, there is a puppy-like bark which may be repeated time and again; this was heard only at dusk and may be connected with breeding behavior.

WHITE-LIPPED PECCARY

Tayassu pecari spiradens

This is the only mammal on the Island that can, by any stretch of the imagination, be considered dangerous, and then only under circumstances which are seldom met. They are for the most part nocturnal, occupying the more remote portions of the Island, and are infrequently seen — the first ones reported by a scientist having been seen by Dunn in 1929. Since then, others have been seen, but exclusive of the three that hung about the clearing for a period, only a few times. In spite of a definite search for the species, it was not until 1932 that they were encountered.

They were not very large. While no specimens have been weighed, comparison of size with the Collared Peccary of which several were weighed, leads to the belief that not many White-lipped Peccary weigh over one hundred pounds. They are slender and high, with massive heads. They do not appear to be sleek and well groomed like the smaller peccary, nor do they look as fat. The hair is sparse and very coarse, the skin showing dark between the hair. A group of visitors saw three one day, and laughed at a warning to treat them

with respect — they said they were too much like barnyard pigs to fear, and in the next breath begged reassurance as to their safety from any Pumas they might meet during a walk to the tower!

These three animals, a young boar, an old sow, and a mature sow, stayed about the clearing for more than a month in 1932. They were in poor condition, so it was thought that they came to the clearing because of the failure of the foods normally found in the forest at the end of the dry season. Here they fed on guinea (*Panicum maximum*) and Bermuda grass (*Cynodon dactylon*) as well as native species of *Paspalum*, and other low-growing herbaceous plants, fallen fruit, and whatever food, including bananas either green or ripe that was tossed to them. Undoubtedly, they played a part in the destruction of the root plants and bananas in the plantation. In the forest they were found feeding upon *Heliconia* spp. eating both the tender base of the stalk and the succulent leaf base as well as the thick, erect stems of *Dieffenbachia Oerstedii*. How they can eat this plant with its skunk-like odor and needle-sharp, irritating crystals is difficult to understand. Probably, whatever forms food for the Collared Peccary is eaten by the White-lipped too.

When the White-lipped Peccary moves into a region, other mammals move out. Thus tapir tracks were abundant on the stream beds and the delta at Fuertes House, until White-lipped Peccary appeared. No more tapir tracks were seen again until after the peccary left. A pet White-tailed Deer kept at the laboratory was very much alarmed whenever he winded them, but displayed no fear or agitation when Collared Peccary were about.

The trio about the clearing gave ample opportunity for observation of their habits. They were not nocturnal, though they did spend much of the day in a wallow which they made at the outlet of the drain from the laboratory shower bath. Enough water flowed out to keep the wallow muddy. This wallow was under a tree and well shaded. Another was by the side of the brook, which, although near the edge of the forest, was not used as frequently. When approached too closely, they left the wallow and disappeared into the edge of the forest where they stood watching the intruder. If, in using the lower path, one came between them and the forest there was a tendency to make a bolt for the forest on the part of the peccary, as well as a marked nervousness which was reflected by the cause of the disturbance. In one instance, when the writer was returning from a tour of his traps and discovered too late that the wallow had been occupied in his absence, he willingly let the wallowers have right-of-

way while he retired behind a tree with conveniently low limbs. Not that the peccary paid any attention to the intruder, they did not need to in order to bring about this action.

When disturbed, the jaws are clamped and the disturber eyed intently. Then, usually but not always, a retreat is made. The young boar did much more of the snapping than the sows, and was much more cocky. In fact, it was he who charged Shattuck while he was taking moving pictures of the group and approached too closely to them.

By tossing bits of bananas to them, the sows were coaxed to within seven feet of the camera. They showed little pugnacity, but clicked their jaws, after dashing off some thirty or forty feet. At other times, the old sow would walk off slowly, snapping as she went.

One afternoon, the same sow was standing across the path near the laboratory, so a stone was thrown at her. It struck her on the muzzle between the eye and nose. She wheeled about, turned her head toward the side from which she had been struck, and, snapping with great rapidity, swung her head upward and outward in such a manner that her formidable canine teeth would have inflicted a long, slashing cut had they encountered an antagonist. After fighting the air for a few seconds, she ran down the clearing and into the forest.

This peccary moves in groups of from three to a hundred or more (Chapman, 1929, p. 212). At times, solitary individuals may be encountered, but as a rule bands of ten to twenty are more common. Flashlight photographs by Chapman, and observation by Carpenter confirm this statement. If it became desirable, a large series of specimens could be collected on the Island for they are abundant in certain densely forested parts. Most of the encounters with this species, excepting the three about the clearing and the herd referred to by Chapman, as far as the writer knows have occurred beyond the tower and chiefly to the west of Armour Trail. Judging from signs they are most abundant in the large area lying between Fuertes House and Zetek. Donato refers to a herd of "several hundred" (Chapman, 1929, p. 212). This must constitute about the total population of the Island. It is difficult to picture anything smaller than a Jaguar being rash enough to attack a full-grown individual. They may not weigh over one hundred pounds, but they are nimble and fierce fighters. Moreover, since they are, usually, associated with others of their own species it would be more dangerous to attack them. Natives say that even the Tigre dare kill only stragglers and then is

sometimes forced to leap to safety. A solitary adult could be killed by a Puma and possibly by an Ocelot, but the writer knows of no such records.

One individual was found dead. Examination of the skull disclosed a broken tooth with the surrounding bone infiltrated with pus, so the animal died, probably, of starvation and the infection.

When moving or resting, individuals can be seen rubbing each other about the dorsal musk gland. This they do to a much greater extent than the Collared Peccary. The ventral surface of the muzzle is passed over the region of the gland, and the sides of the head rubbed along the flanks. The musk is characteristic, and a group that can be smelled but not seen is easily identified as White-lipped Peccary. He who said that their odor is "the quintessence of unwashed negro humanity" described the odor of the musk far, far better than could the writer. This odor is the most offensive encountered in the forest of Barro Colorado Island.

Chapman (1929, p. 212) refers to the use of the trails by the White-lipped Peccary. This species, unlike the Collared, shuns heavy undergrowth, neither does it make trails through tangles. Living in the dense forest, the floor of which is comparatively open, they move in a more or less compact group instead of single file as do animals passing along trails through tangles. This habit of moving in groups accounts for the numbers photographed by a single exposure.

The voice is not unlike that of the Collared Peccary. Apparently, the White-lipped is rare elsewhere in the Canal Zone, possibly because of the lack of primeval forest, and hunting. Along the upper Pequeni and Boqueron they appeared to be fairly common.

WHITE-TAILED DEER

Odocoileus rothschildi chiriquensis

The White-tailed Deer is more frequently seen on the Island than the Brocket as it finds considerable areas suitable to it. It "favors the forest borders of the dense thickets and mixed growth of small trees and shrubby vegetation which springs up wherever the original forest is cut." (Goldman, 1920, p. 77). As a sharp line of demarcation divides the Island into two nearly equal portions, the second growth lying to the east (Kenoyer, 1929, p. 214) — which portion is traversed by the main traveled trails — this is to be ex-

pected, even though this species of deer may not equal the number of Brocket Deer present on the Island.

Many White-tailed Deer are killed by the hunting clubs using dogs and hunting over the Pacific half of the Canal Zone where pasture and shrubby forest intermingle, reproducing conditions closely approaching those found in the forest above the savannas which is the natural habitat of this animal. Like the northern species this deer has extended its range because of its adaptability to clearings, agricultural and constructional, and the killing off of its enemies. On the Pequeni, where this deer was abundant, several "forms" were found. One such form from which we frightened the occupant at about 9.00 A.M. was in a spot that was fairly free from undergrowth. This showed signs of frequent use. Another was located on a hillside in a group of small trees which offered very little visual obstruction for the canopy was high, but did offer considerable impediment to a straight swift charge.

Native hunters, using the jack light, are killing these deer off at a rapid rate.

Pets of this species have been kept at the laboratory. One young male just old enough to develop horns would slip his collar, dash about the clearing for a time, then make for the lake from which he had to be forcibly removed. When pursued by dogs, wild individuals enter water without hesitation. This male would take food such as lettuce trimmings and pilot bread, and place them in the water of his pan before eating them, appearing to enjoy eating under water.

This captive was very much alarmed by White-lipped Peccaries, but not by Collared Peccary, the two species being, apparently, distinguished by odor and sound alone, as they were out of sight at the time. When a tame Agouti dashed into the clearing squealing in alarm, the deer stamped with one forefoot, then with the other. If irritated by a human he would rear up on his hind legs and strike rapidly with the forefeet, either singly or simultaneously. There was a tendency to rest during the afternoon, and then to feed actively during and after sunset, a habit of which Sylvestri took advantage by placing guinea grass in the pen for which the deer would dash when the rope was untied. In the morning flies bothered him a great deal causing him to do much leaping about.

The problem of whether or not this deer has a definite breeding season as does its northern relatives is of interest. The only way it can be solved is by a collection of dated early embryos in which project all hunters are coöperating. Goldman (in above) reports

a lactating female in January. Horns began to grow on the laboratory animal in April and by the first of July, he had attempted copulation with a mature female furnished by the Gatun Station Zone Police for a breeding experiment. Professional native hunters say that this deer has no breeding season, for embryos are found during many months of the year. Occasionally two fawns are produced.

On the island the enemies of the deer must be the larger cats. Chapman (1929, p. 207) reports excreta of either the Puma or Jaguar, probably the former, containing White-tailed Deer bones. They must be able to avoid the White-lipped Peccary which they appear to fear, but not the cats which hunt them for food.

Reports on the size of this deer vary. One buck, after evisceration, weighed 115 pounds, and another 140. These two bucks were larger than average, but indicate that while the Chiriqui White-tail does not attain the size of the northern Virginia deer, it is larger than the deer of Florida which are reported by Cory (1896, p. 63) to weigh about 80-90 pounds, but not over 110.

Because of the abundance of large cats on the Island, it is doubtful if there are more than eight or ten deer there. The food requirements of this deer are easily met as it appears to consume grasses and fruits, principally figs, as well as to browse.

BROCKET DEER — "VENADO COLORADO"

Mazama satorii repertica

The Brocket is confined to the deeper portions of the forest which are remote from the laboratory and is very alert, so is not seen often; nor does it dash off when disturbed, displaying a white patch to advertise its presence, but moves off quietly if not too closely pressed. Brocket are fairly abundant, all things considered, in the region between Fuertes and Zetek, and about Zetek Trail. Carpenter and Dr. Chapman have seen Brocket, and old Mex reported seeing individuals here on several occasions. The remarks published (Enders, 1930, p. 285-286) apply to the White-tailed Deer (*Odocoileus chiri-quensis*) and not to the Brocket.

Many skins and several specimens were seen on the Chagres where the Brocket is called "Venado Colorado." The flesh is eaten, the skins tanned, and the offal used in fishing.

With the clearing of the area to be submerged by the waters of Madden Dam, much of its habitat has been destroyed, which may

account for the numbers killed here. It is also possible that the opening up of this area to white hunters and the consequent killing off of the larger cats has resulted in an increase in numbers. The only record of a Brocket serving as food for a cat was secured on the Island where hair from the belly of one was found in the seats of an Ocelot.

BAIRD'S TAPIR

Tapirella bairdii

Alston (1879, p. 103) quotes a statement of Captain Dow that the favorite haunts of this tapir on the Isthmus "appear to be in the hills lying at the back of Lion Hill and the adjoining stations of the Panama Railway. It is only during the rainy season that they seek the lowlands." This region embraced Barro Colorado, so it is not surprising to find abundant signs of tapir on the Island.

As Goldman (1920, p. 82) remarks, "These tapirs are very shy and seldom venture outside of the denser forest cover." However, that they are not confined to such cover is demonstrated by the frequency with which they are encountered by dogs hunting deer in the quebradas in the pastures of the Cattle Industry. On the Island tracks may be seen at almost every estero, and baths or wallows on many of the small streams. Many appear to frequent the areas where, following the setting aside of the Island as a preserve, plantations were abandoned, leaving a very dense second growth which extends down to the lake shore with its heavy growth of grass.

It is not to be thought that the tapir are confined to water courses or the lake shore, for they appear to be great travelers and able to live at some distance from the water. This is borne out by automatic flashlight photographs made by Dr. Chapman, as well as by the deposits of dung found far from water. Moreover, the feces indicate that they browse in addition to eating the grasses (chiefly *Panicum barbinode* and *P. grande*) found in large masses in the lake. Here browsing is a more important item in their economy than grasses; whether the same holds true for the individuals living in and near the pasture lands was not determined as no feces or stomach contents were found. But in many regions such as in the mountains where tapir occur, grasses are not abundant.

In an old clearing on the Pequeni, tapir had been feeding extensively upon the wild papaya that had formed a considerable thicket. The trees had been straddled and then "walked down" until the stem

broke; the fruit was then eaten and here and there a mouthful of leaves from the top of the tree consumed. The passage of a tapir feeding in this manner makes a well-marked pathway of destroyed trees. In the same clearing *Cecropia* (*C. arachnoides*) had been eaten.

Tapir may utilize one region for a considerable length of time as shown by trails they make, and the amount of dung deposited about wallows. Such trails are not very conspicuous, unless one happens upon them, for in spite of the great weight of the animals, the height is not such as to make a trail that is easily visible to man. These trails are particularly well marked where they lead across a narrow neck of land over which the animals must pass in going from one estero to another, or where they pass along the side of a steep declivity. They are also users of the man-made trails on the Island as Chapman's photographs show. Tracks indicate that the water courses are also used as highways.

There is a decided tendency on the part of the species to enter and emerge from the water at the same place, time and again. Nor is it improbable that more than one animal uses these entering places. Sometimes several trails may lead to one side of an estero, or inlet, but on entering the water all routes converge to one point, so that only one landing place is found. Similarly, animals traveling in the opposite direction all enter the water at this one place, but may leave it at any of a half-dozen places on the opposite shore. This suggests a deliberate choice of a point of departure where the tapir enters the water, and leads one to conclude that the native who insists that tapir do not swim but walk across an estero or river, regardless of the the depth of water, with the feet upon the bottom, has apparently observed the animals doing this, for all routes converge to a place where a sand bank, offering a much firmer footing than the soft mud of the rest of the bottom, runs out into deep water. It is easy to understand how an observer watching an animal walk out into the water along such a bar until only the back was visible and then seeing that disappear, only to see the animal reappear on the opposite bank, would gain this impression. For as Chapman's (1929, p. 229) photograph of an emerging tapir demonstrates, only a small portion of the head appears above the water — so small a portion that the animal must be all but invisible in poor light. Be that as it may, the native sticks to his belief that the tapir walks under the water, and frequently can point to a long sand bar along which the tracks of the tapir lead to deeper water.

Another belief, not altogether confined to the native, is that defe-

cation can take place only in water. To support this contention, the undeniable evidence of feces lying about wallows is cited. That defecation does take place in these baths is granted, but the tapirs living some distance from water could not return very frequently. Moreover, deposits are found on the hillsides, far from streams, where there can be no standing water. Carpenter reports seeing such deposits, too. Much time, apparently, is spent in wallows so dung is expected there.

These accumulations vary in size, doubtless with the length of use, as well as the frequency and the number of animals. Feces disappear rapidly in such a moist climate and with so many insects, so when a collection of dung balls covering an area thirty-five feet in diameter was found, it was interpreted as the product of more than one individual.

The feces are rounded, somewhat smaller than a baseball, and reflect the nature of the diet. Most of the balls are rather dry, consisting largely of woody fiber that has passed through the digestive system of the animal with little change. Others indicate a less resistant fiber — as of grass — in which case the feces are more moist and are not unlike, in content as well as moisture, the dung of a horse that has been feeding upon succulent grasses.

The baths or wallows may be located in a small stream in a basin at the bottom of a waterfall, in an estero, usually where a small stream enters, or in a depression. If in the latter, it is abandoned as it dries up with the waning of the rainy season. Such a wallow may be very extensive, one found in a depression on the neck of the point where Bang's House is located being thirty-five or forty feet in diameter. Insofar as they wallow in both wet and dry seasons, it is possible that wallowing is resorted to in order to avoid the mosquitoes, flies and other insects, or in an attempt to allay the irritation of the ticks of which they have many.

Usually, tapirs are nocturnal, spending the day resting in thickets or vines or near logs. No tapirs were surprised in daytime in their wallows, and, as these baths were often muddy in the morning, it may be that they are resorted to chiefly at night. Sylvestri reports that while clearing a trail, he jumped over a log onto a pile of brush under which a tapir was sleeping. The surprised sleeper dashed out and made off, but did not go far before stopping to stamp and snort.

Paddling along the shore of the Island near the watchman's shanty which is but infrequently used, Sylvestri drew my attention to the

snort of a tapir we had disturbed. We located the bed in the tall grass near the lake shore from which the occupant had fled, but neither saw nor heard any more of that tapir.

Mexico agrees with Carpenter and Sylvestri that, when surprised, the tapir may snort and stamp with its forefeet. Some natives fear the beast for this reason. At other times, particularly when started by dogs, they rush through the brush and tangles, making much noise. One man on horseback came upon a tapir in the pastures and shot the animal while it stood gazing at them.

To judge from this last incident, sight is not very good, which raises the question of the keenness of the various senses in the tapir. From reports of observers and from photographs examined, one is led to the belief that hearing is most highly developed. The structure of the outer ear encourages such a statement, also. The snorting and circling of an animal when surprised may be an attempt to catch the tell-tale scent of the disturber. At least when really frightened the eyes do not function any too well, for while the fugitive does not bump into large trees, small stuff is passed over or through in what has every appearance of a blind dash. Of course the weight of the animal carries it through tangles that to the eye of man appear to be impregnable, so this lack of visual discrimination may be far more apparent than real.

What the enemies of the tapir are aside from ectoparasites cannot be stated without reservation. Of course, some on the mainland are shot by hunters, but on the Island, only their natural enemies limit their numbers. While young, any of the large cats could easily kill them, and doubtless the Jaguar could kill adults. Tracks on the Island indicate that the young stay close to the mother until about half-grown.

In 1932 tracks of a very small tapir associated with an adult were seen on the Wheeler Estero, and those of a half-grown specimen with adult tracks accompanying it near Peña Blanca, indicating that reproduction is going on on the Island. The period of gestation is commonly reported as 400 days, so reproduction is not rapid.

But how many "mountain cows" are there on Barro Colorado Island? Chapman, in a letter to the writer, draws attention to the fact that his photographs indicate that tapir cross the Island, a habit that increases the difficulty of estimating their numbers. He places the number at ten or twelve. Sylvestri said that there were ten males and as many females; Donato said there were not as many as twenty; Carpenter believes the numbers are even smaller. Twenty is the

number the writer would assign to the Island, believing that number to be conservative.

Apparently tapir do not share the same feeding grounds with the White-lipped Peccary. Thus tapir tracks were abundant along the stream near Fuertes House in late 1931, but no more were seen leading to what had appeared to be a favorite wallowing place, once the region was occupied by a band of "Puerco del monte." In February of 1932, the Puerco moved out of the territory which, within a month, was reoccupied by tapir. This same observation has been made in several places but what underlies it was not determined. It is doubtful if competition for food is the determining factor for feeding habits are not similar. More likely it is a problem involving the use of wallows, or just plain antagonism toward the tapir on the part of the peccary, or fear on the part of the tapir. Since the foregoing was written, Carpenter has sent the writer the following:

"Tapirs are rarely observed even by careful naturalists working in regions where they are numerous. On Barro Colorado Island where they abound I saw only one instance of their behavior. Furthermore, during twenty-six days of field observation work on the La Vaca River of Western Panama, I made only two contacts with living animals.

I was attempting to locate a clan of Howling Monkeys on Barro Colorado Island in January, 1932. The region was between Shannon and Barbour Trails. Suddenly two bulky forms sprang up before me, the larger snorted, advanced in my direction, and at the same time stamped the ground, presumably with her front feet. The animal which came toward me revealed clearly its downward turned nose typical of the tapir. I would estimate its height at approximately thirty inches, and from the brief glimpse that I was afforded of the lesser one, I would guess that it was about half that height. For fifteen or twenty seconds the large animal continued its stamping, snorting, and apparently aggressive activity; the young one moved away from the observer. When I approached, in order to get a better view, both animals dashed away through the tangled underbrush while the larger of them continued to make the snorting noises.

In the vicinity of the La Vaca River tapirs are unusually numerous as judged by tracks and other indirect evidence. The tracks of several different animals may be seen in the space of three miles along the river. About one o'clock one morning as my guide and I were hunting for these animals with hunting lights, we heard one come

down a steep bank, and then saw its eyes flash as points of reddish light from the reflections of our lamps. The animal turned and ran away in the direction from which it had come. Its presence was confirmed the next morning by the fresh tracks.

The La Vaca River is a very winding water course especially towards its source in the hills. Tapir do not generally follow the course of the channel but cut across the higher ground or hills around which the river flows. Often they climb very steep banks and knolls over which their toes afford them secure traction. Trenches three or four feet in depth are to be seen where tapirs have formed pathways; the trenches were probably cut by generation after generation of tapirs and by the action of the water. Native guides tend to follow and depend on the tapir pathways and frequently cut in half the time that is required to reach a certain point on the river by following the tapir trail rather than proceeding in the river channel.

Once my guide and I came upon a place where there were several tapir beds around which were piles of fecal matter. Evidently the tapir had used this place as a bedding spot many times and the various trails leading out from this vicinity support this conjecture. The location was on a high hill and in a place of fairly dense vegetation. Some three hundred yards from this spot we heard a large animal come slowly toward us then stop, turn, and dash off in the opposite direction up a bank. Later we observed the soft ground considerably scarred by the tracks of a tapir. The indications are that tapirs are very keen of sense in detecting strange living things.

Tapirs eat coarse, tough ferns, palm leaves, and grass that would not be eaten by either horses or cows. Also there are several species of trees from which they gnaw the bark of the buttress roots."

THREE-TOED SLOTH

Bradypus griseus

While sloths occur on the Island they are not seen frequently for they spend much of the day immobile and when they do move, it is so slowly as to attract no attention. Moreover, they appear to frequent taller trees. There is no reason to believe that there are fewer sloths on the Island than in the forests on the mainland where, to judge from the numbers purchased from natives, they cannot be considered rare. The Three-toed Sloth is more abundant, or possibly the easier of the two to secure, for in response to an offer

of a dollar for each female Three-toed Sloth and the same sum for any Two-toed Sloth, more than twice as many of the first genus were secured.

The Three-toed Sloth is notoriously difficult to keep in captivity. However, if given an abundant supply of cecropia leaves and sufficient room, they thrive. In addition to cecropia leaves, they also ate the leaf of an unidentified herb which grew in the clearing, but did not do well on this food. Many sloths were thus kept, some for a period of months, and much of what is here recorded was learned by observing the captives.

Ample opportunity was given to check Wislocki's observations (1925, pp. 320-321) on the posture of this genus of sloth. When not traveling along a limb the body is more or less perpendicular; even when feeding this posture may be maintained. As Wislocki says, it "spends most of its time asleep and waking in a sitting or squatting position, its hind limbs embracing a stem or crotch of a tree, while its arms are free to be used for grasping foliage to be guided toward the mouth or for climbing . . . when asleep, the hind extremities are used for support."

The offspring, of which there is but one, is well developed at birth. It clings to the mother much as a young monkey, for the mammae are pectoral. The young one, although usually seen with the limbs about the thorax of the mother, may shift to the back — always maintaining a more or less upright position. One was observed hanging onto the hair over the rump of the mother which was in turn clinging to the wire netting of the enclosure with the weight supported by the hind legs. This caused the thorax to rest upon the anterior aspect of the hind legs, so eliminated the space usually occupied by the young one. This is, probably, a frequent occurrence under natural conditions.

In captivity, the animals do little or no fighting, even when there are several males and females in the same cage. However, when two females, one of which was carrying a baby were placed together, the one without the baby attacked the other during their first night together. The baby was clinging to the pectoral region of the mother when the attack was launched. She curled up to protect the baby, covering effectively, while the attacker chewed her left hind leg. The mother shrieked more or less constantly during the fray, but settled down as soon as they were separated. The leg was lacerated to a surprising extent, in view of the thick, tough skin with which the sloth is covered.

It is possible that there is a somewhat definite breeding season in this genus. Females received in January either had babies with them or were pregnant or both. However, one which was received on December 9 carried a good-sized baby, which died December 29. The mother was observed copulating, and when killed January 29, proved to be in the early stages of pregnancy, the embryo being in the late somite stage with limb buds according to Wislocki. Females taken later in the season were not pregnant.

Copulation extended over a period of two days. A young male was placed in the cage on December 30. It was observed from time to time that the two animals were together. Assuming the position venter to venter, the male which was the smaller of the two, embraced the female with both fore and hind limbs. This embrace would last for several hours, the little moving about that was done during this time was accomplished through the efforts of the female for she carried the male much as she would have a very large baby. In fact, it was not until later when the uterus was examined and she was found to be in the early stages of pregnancy, that copulation was suspected. As this was the only male in the cage and the animals were under constant observation, the writer does not suggest that it was at this time that impregnation took place. Two days after the onset of this activity which, as has been said, covered a period of two days, the male was killed by accident. The placentation of this sloth and the characteristics of the fetus have been well covered by Wislocki (1925, 1926, 1927).

That sloths of this genus can swim has been noticed by many observers (Belt, p. 209). None were seen swimming, but one was found dead in the water, more probably having been thrown overboard from a passing ship than a victim of drowning.

After one half-grown individual had been found dead in the rising waters of Madden Dam and several others reported, a female with a young one was placed in the water. As she struck for the dock, the young one continued to hang on to the ventral surface, in which position it might have drowned, had they not been fished out. It is suggested that this may account for the number of immature specimens found drowned in the newly formed lake.

Sloths offer many opportunities for physiological research, particularly on the physiology of sex. The testes are intra-abdominal, and the interstitial cells are abundant (Wislocki, 1928, p. 359). Moreover, the male has a conspicuous mark upon his back, a secondary sex character, distinguishing him from the female. Castration and

transplantation experiments might contribute to our knowledge of sex physiology. The Two-toed Sloth has even more interstitial tissue and could be used as a check. The animals are fairly easily kept.

The external parasites of the sloth have been described frequently. "In *Bradypus griseus*, the duodenum invariably contains a quantity of nematode worms. These never have been found in *Choloepus* in the present series." (Wislocki, 1928, p. 341.) These parasites were identified by Dr. G. Stoener as *Leiuris decodontus*. Dr. Chapman saw a young Puma eating a Three-toed Sloth but could not determine how the animal had met death.

One individual, a male, fell a distance of five feet landing flat on his back; this resulted in death. Otherwise they are difficult to kill being resistant to ether and almost immune to systemic shock.

TWO-TOED SLOTH

Choloepus hoffmanni

This large sloth is not seen very frequently on the Island, for its habits are such that it is easily overlooked. However, J. B. Shropshire supplied the laboratory with them in numbers, so they are not rare if one looks for them. On March 8, 1932, Shattuck brought in a mass of hair from remains he found in the forest between Shannon 5 and Wheeler, and Carpenter saw a large individual at Donato 3. Others have been seen from time to time.

While no observations were made in the field, many sloths were kept in captivity for periods of some length. They were fed on Cecropia leaves and the leaf of a herbaceous plant growing in moist places on the clearing. At Pedro Miguel, specimens have been kept for two years, while Wislocki and Richter transported several to Baltimore where they were kept for over a year. In each case, the sloths ate a wide variety of foods, including bananas, spinach, lettuce, carrots, potatoes, and other produce, so they do not present the difficulty encountered in attempting to keep alive the Three-toed Sloth.

This species is much more vigorous in self-defence than the Three-toed, moving the legs with great speed. Moreover, the dental armament is more formidable. It is not as pugnacious toward cage mates of the same or another species.

Twelve females were examined. Of this series two, taken in late December, were lactating and accompanied by young six hundred

to seven hundred grams in weight. Subsequent examination showed both females to be pregnant. This indicates that copulation may take place shortly after parturition. The other ten mature females which were examined between December and March were neither lactating nor gravid.

This sloth, too, is a swimmer. Individuals placed on a small island disappeared, probably swimming away across the same stretch of water covered by the howler and *Cebus* that escaped from the same place.

TWO-TOED ANTEATER

Cyclopes dorsalis

This small anteater is usually golden-yellow in color with a very soft, silky pelage — only one of the specimens secured being grayish with a very distinct dorsal stripe. Although not frequently seen, they are abundant on Barro Colorado as demonstrated by the number taken in the course of clearing the ground about the laboratory. They are strictly nocturnal and arboreal, they move slowly, nor do their eyes reflect the rays of the hunting lamp. Captive specimens spent the day and considerable portion of the night curled up in boxes built to imitate cavities such as are found in trees. For these reasons they usually escape observation until one comes across them during felling operations. The writer believes that, in dense forest such as is found over about half of the Island, they may average one to an acre. On the other hand, Shropshire, in a note concerning the capture of live specimens says . . . "they are rare. We usually get them asleep in the 'Zamia' patches in the mangrove swamps."

Captive specimens behaved differently from an individual of this genus described by Bates (1888, p. 178), for they never clawed out with the forepaws nor did they remain silent when irritated. In each case, a stick in the cage was firmly grasped with the hind feet, the body elevated into an upright position, the forepaws with the claws in resting position were pressed to each side of the face, and uttering a distinct hiss with each movement, the animal bowed time and again toward the disturber. That this is a usual reaction is shown by the fact that a mention of its name leads natives to imitate these movements, or an imitation of these movements is sure to elicit the animal's name. Van Tyne (1929, p. 314) reports somewhat similar behavior.

"The small anteaters, of which the smallest, *Cylchura didactylus*,

may serve as a good example, are arboreal. Their tails are long, with powerful flexor muscles, the action of which is increased by the existence of chevron bones opposite the bodies of the vertebrae. *Cyclura* has peculiar, but very efficient, grasping feet, especially well developed on the hind limbs. It lives among the small branches near the tops of high trees. It has a habit of grasping a branch with its hind feet, another with its prehensile tail, and upon the extensive tripod base so obtained not only erects its body, but bows and sways to and fro, apparently for amusement. It probably often pursues the ants upon which it feeds by the same motion." (Reynolds, 1931, p. 283.)

The hind feet are so well developed that the erect posture can be assumed and maintained without any assistance from the tail. Moreover, it appears to matter little whether the toes are pointing forward or backward for when one is surprised the body may be raised with one foot in the normal position, toes to the front while the other is reversed or both may be reversed. The leg muscles of this species would repay anatomical study. The only food eaten by captives was termites, whole nests of which were placed in the cage. Nevertheless, no specimen lived more than eight days in captivity.

Mr. Zetek purchased a female, with a young one almost as large as herself, clinging to her, in early March. It is possible that the anteater has a breeding season in December and January similar to that of the Three-toed Sloth. One young is usually born (Wislocki, 1928, p. 71; Ryder, 1887).

The respiratory rate of a resting specimen was 27-28 per minute.

THREE-TOED ANTEATER

Tamandua tetradactyla chiriquensis

The Three-toed Anteater is both terrestrial and arboreal. It was found all over Barro Colorado Island as well as in the Forest Preserve, in the orchard of the Experimental Gardens, and in the tall guinea grass (*Panicum maximum*) of the pastures of the Cattle Industry. The anteater is essentially nocturnal, but is seen abroad at any hour of the day — at least on the Island. The eyes, which are small, reflect the rays of a hunting lamp, but are dull and difficult to see.

Of its food, Goldman (1920, p. 63) says, "an example brought in by a native hunter had at least a pound of ants in its stomach. These have been determined by Theo. Pergande of the U. S. Bureau of

Entomology and found to represent five genera, as follows: *Camponotus atriceps* Smith, *Dolichoderus bispinosus* Mayr, *Pseudomyrma pallida* Smith, *Aphaenogaster* — sp.? and *Cremastogaster* — sp.? Most of the ants were in a larval condition, but some were already winged." A young female shot by the writer contained one-half kilo of ant larvae, while another specimen had eaten somewhat less. As most of the specimens were taken alive and kept for some time, not many stomachs were examined.

They are easy to keep in captivity for they can be fed by placing nests of ants and termites in the cage. Termite infested wood is attacked and torn apart with powerful claws of the forefeet, and the tunnels emptied by the use of the tongue. This tongue is truly a remarkable instrument for it is capable of following a tunnel to its end, and then passing over to a parallel tunnel; the tip may clear it out by moving in the opposite direction from the base. This was observed on several occasions while holding dead branches and termite ridden papaya leaves from which an anteater was feeding.

There is a very characteristic odor which is similar to that of the urine. This is so strong that, after becoming familiar with it, one recognizes it in the forest. The dung, too, has a characteristic odor as well as appearance. It is always surrounded by a strong, impervious sheath that has the appearance of mucus and which holds the fecal matter in shape even when it is deposited in water, as it frequently is. In water the "sheath" absorbs moisture, becomes whitish, but does not disintegrate for several days. As to the source of this covering and its use, the writer can only speculate at present; later he plans to make a histological study of the colon and rectum and thus attempt to find an explanation. At present it can be said that this is mucus believed to be deposited about the feces as they pass through, or as they lie in the lower portions of the digestive tube and that, if in the anteater as in other *Xenarthra* such as the sloths, there is considerable storage of fecal material before defecation, this coat may prevent the absorption of decomposition products set free by undigested remains of a high protein diet.

On several occasions anteaters were found lying beside the highway passing through the Forest Preserve, victims of the new danger, the speeding automobile.

Lactating females were examined in November, December, and June, while half-grown young were seen in November and January, so there may be two breeding seasons or a continuous one. As in the sloths, the mammae are two in number and pectoral; the young

are carried on the ventral surface of the thorax. From the behavior and examination of a captive female, one might judge that they breed again about three weeks or more after parturition.

The anteater has a rather unusual nasal cry, somewhat like that of a suction pump when the liquid in which the intake is placed is so low that both air and liquid are taken up. This cry was uttered by a captive female, but it was not until it was observed time and again that the writer could be convinced of its source, for the sound was so unexpected. At first calls were attributed to hunger, but feeding did not stop them. Single calls were made at irregular intervals. Most calling was done between 5:00 P.M. and 6:00 P.M. Examination of the captive indicated that she was in heat. This call was heard in the forest on several occasions, always in the evening.

A half-grown individual was kept in captivity for some time. She became quite tame, even coming out of her box to be taken up. A series of rectal temperatures were made, but that did not frighten her, nor make her wild. Later she escaped by prying off a board that had been nailed against the supports on the inside of the cage and then enlarging the hole in the wire thus uncovered.

While this anteater is both terrestrial and arboreal, more are seen on the ground than in the trees. On the ground they move slowly walking with the claws of the front feet curled inward, a habit that results in a very characteristic track. They are clumsy walkers, and make considerable noise in moving about. When thoroughly aroused, they move at a gallop but are easy to overtake. When surprised on the ground, they make for a tree climbing rapidly and attempting to keep the trunk between themselves and observer. Frequently one will climb over a hundred feet upward to be lost in the maze of the forest canopy. Climbing is not limited to trees for they clamber over vines of small diameter and do much travelling and feeding in the masses of vines with which many of the forest trees are covered.

If it fails in an attempt to escape a pursuer, the anteater is very willing to fight. Two main methods of defense are employed, the one chosen depending on several factors. Either the animal lies on its back with all four feet in the air, or rearing up on its hind legs, it will assume what may be called the "tripodal posture." Regardless of which type of defense is utilized, considerable hissing and waving of the head accompanies it.

The effectiveness of the position with the four feet in the air is realized when an attempt is made to hold the animal down under a

board. In addition to clawing with the forepaws, the board edge is grasped and a powerful grip which brings the claws into play is applied, and, bringing into play the powerful muscles of the back and legs, the animal exerts considerable force on the board in the meantime squirming out from under it. Usually the bladder is emptied during the struggle and sometimes the animal defecates. How effective such a defense is the writer cannot say.

As soon as the fore part of the body is free the anteater rears it off the ground using the forearms with great effect. Once out from under the impediment, the animal assumes its most characteristic defense pose — the body erect, hind feet firmly planted wide apart, the heavy tail pointing out behind and pressed to the ground serving as the third leg of the tripod, the strongly armed forepaws ready for striking. The body is capable of extensive movement over the wide base thus established, and a surprising amount of force is necessary to destroy the animal's equilibrium. Unlike the giant anteater which, in this position, uses the tail as a counterbalance only, the Three-toed Anteater does not resort to a quadrupedal gait when it shifts position but can move with celerity in any direction without abandoning the erect attitude.

One female allowed herself to be driven backward a distance of two feet before a thrusting stick, until, by grasping the stick in her claws she jerked it from the writer's hand and then charged forward for six feet before stopping — all the while retaining her balance and the erect posture. Another individual charged with astonishing speed from this position, the body inclined forward, the right forepaw poised for a blow, the tail, during the charge, serving as a counterbalance but being pressed again to the ground as soon as the animal stopped and reassumed the erect position. Against the attack of what enemy does the anteater use this method of defense? The writer does not know but can vouch for its effectiveness.

NINE-BANDED ARMADILLO

Dasypus novemcinctus fuscistratus

The only armadillo captured on the Island was picked up on a trail early one evening. Although not often seen, there are many on the Island, for tracks are seen everywhere and "workings" are numerous. Along the Chagres River, they are even more abundant and are frequently seen at night where some suffer, as do their kin in

Texas (Bailey, 1905, p. 56), when a disappointed deer hunter succumbs to the temptation to "get even" with one for the nervous strain imposed upon him by the rustling of leaves by an armadillo.

A captive specimen, an immature male, was tethered and taken into the forest to observe feeding habits. He plowed along with his snout in the loose litter on the forest floor, pausing from time to time to dig. It was impossible to determine what he was eating, but in all probability, all larvae, grubs and beetles found were eaten. When food was encountered he paused long enough to eat it, then hurried on. Doubtless the range of food eaten in Panama is no less than in Texas where "insects and other small life, including many species of grasshoppers, crickets, roaches, caterpillars, beetles, ants, spiders, centipedes, and earthworms" (Nelson, 1918, p. 223) are reported from examination of stomach contents.

While this specimen dug very rapidly in feeding, no attempt was made to escape by digging in. The claws of all four feet were used effectively in securing a purchase on the slightest projection of a perpendicular clay bank up which he chose to climb.

While in captivity, he spent most of the day coiled up under the litter in the cage, but rose from time to time to sniff the breeze, but the night was spent in attempting to escape, chiefly by unsuccessfully digging at the galvanized iron floor. He made a most unpleasant captive for the odor of the urine is very strong and offensive. This odor is encountered in the forest, and while similar to that of the urine of the Three-toed Anteater (*Tamandua*), yet it is characteristic enough to be specific.

BIBLIOGRAPHY

ADAMS, L. A.

1928. Banana Stowaways. *Science*, 67:218 No. 1730.

ALLEE, W. C.

1926. Distribution of Animals in a Tropical Rain Forest with Relation to Environmental Factors. *Ecology*, Vol. 7, no. 4.

ALLEE, W. C. and M. H.

1925. *Jungle Island*. Rand McNally and Co.

ALLEN, G. M. and BARBOUR, T.

1923. Mammals from Darien. *Bull. Mus. Comp. Zoöl.*, Vol. 65, No. 8.

ALLEN, J. A.

1900. Descriptions of New American Marsupials. *Bull. Amer. Mus. Nat. Hist.*, Vol. 13, pp. 191-199.

ALLEN, J. A. and CHAPMAN, FRANK M.

1893. *Bull. Amer. Mus. Nat. Hist.*, Vol. 5, pp. 225-227.

ALSTON, EDWARD R.

1879-1882. *Biologia Centrali-Americana*. Mammalia, pts. I-XX, 1-220.

ANTHONY, H. E.

1916. Panama Mammals Collected in 1914-1915. *Bull. Amer. Mus. Nat. Hist.*, Vol. 25, pp. 357-375.

AZARA, DON FELIX D'

1801. Essays on the Natural History of the Quadrupeds of the Province of Paraguay. (Quoted from Seton).

BAILEY, VERNON

1905. Biological Survey of Texas. *North American Fauna*, 25.

BARBOUR, T.

1932. A Peculiar Roosting Habit of Bats. *Quart. Rev. Biol.*, Vol. 7, No. 3.

BATES, H. W.

1888. *Naturalist on the River Amazons*. Second Edition, London.

BELT, T.

1884. *The Naturalist in Nicaragua*. Fifth Edition, London.

BENNETT, H. H.

1929. Soil Reconnaissance of the Panama Canal Zone and Contiguous Territory. *U. S. Dept. Agri. Tech. Bull.* No. 94.

BRESSLAU, ERNEST

1920. *The Mammary Apparatus of the Mammalia*. Methuen and Co. London.

CARPENTER, C. R.

1934. A field study of the behavior and social relations of Howling Monkeys. *Comp. Psychol. Monographs*, Vol. 10, No. 2, pp. 1-168.

CHAPMAN, FRANK M.

1893. *Bull. Amer. Mus. Nat. Hist.*, Vol. 5, Art. 13.
 1927. Who Treads Our Trails. *Nat. Geog. Mag.*, Vol. 52, No. 3.
 1929. The Conquest of Claudia. *Nat. Hist.*, 29, No. 4.
 1929. Presenting the Coati. *Scribner's Magazine*. March, 1929.
 1929. My Tropical Aircastle. D. Appleton & Co., New York.
 1931. Seen from a Tropical Air Castle. *Nat. Hist.*, Vol. 31, No. 4.
 1932. In an Eden Where Man Befriends Beast. *New York Times Magazine*. Dec. 4, 1932.
 1932. A home-making Bat. *Natural History*, Vol. 32, No. 6.
 1933. Autobiography of a Bird-lover. D. Appleton-Century Co. New York.

CRANE EXPEDITION

1930. Animals That Climb Their Own Trails or Hang Upside Down By Their Feet. *Ill. Lond. News.*, Feb. 8, 1930.

DARLING, S. T.

1911. *Proc. Canal Zone Med. Ass'n.*, Vol. 3, Pt. 2.

DUNN, E. R.

1931. The Disc-winged Bat (*Thyroptera*) in Panama. *Jour. Mammal.*, Vol. 12, No. 4.

DUNN, L. H.

1932. Susceptibility of Bats to Infection with the horse trypanosome, *Trypanosoma hippicum* Darling, in Panama. *Jour. Preventive Medicine*, Vol. 6, No. 3.
 1932. Experiments on the Transmission of *Trypanosoma hippicum* Darling with the Vampire Bat, *Desmodus rotundus murinus* Wagner, as a vector in Panama. *Jour. Preventive Medicine*, Vol. 6, No. 5.
 1933. Observations on the carnivorous habits of the spear-nosed bat, *Phyllostomus hastatus panamensis* Allen, in Panama. *Jour. Mammal.*, Vol. 14, No. 4.
 1934. Notes on the little bulldog bat, *Dirias albiventer minor* (Osgood), in Panama. *Jour. Mammal.*, Vol. 15, No. 2.

ENDERS, ROBERT K.

1930. Banana Stowaways Again. *Science*. Vol. 71, No. 1843.
 1930. Notes on Some Mammals from Barro Colorado Island, Canal Zone. *Jour. Mammal.*, Vol. 11, No. 3.
 1931. Parturition in the Agouti, with Notes on Several Pregnant Uteri. *Jour. Mammal.*, Vol. 12, No. 4.

GOLDMAN, E. A.

1920. Mammals of Panama. Smith, Misc. Coll., Vol. 69, No. 5.

1933. A new climbing mouse from Panama. Jour. Washington Acad. Sci., Vol. 23, No. 11.

GOODWIN, G. G.

1928. Observations on Noctilio. Jour. Mammal., Vol. 9, No. 2.

GRANT, CHAPMAN

1916. Big Game of the Texas Border. N. Y. Zool. Soc. Bull., pp. 1386-87.

GREEN and SHANNON

1926. Zoopathologica. Vol. I, No. 7.

GROSS, ALFRED O.

1927. Barro Colorado Island Biological Station. Smith. Rpt. No. 2893.

1930. A Jungle Laboratory — Companions of the Wild at Barro Colorado Island. Nature Mag., Vol. 15, No. 1.

HILL, J. P. and FRASER, ELIZABETH A.

1925. Some Observations on the Female Urogenital Organs of the Didelphyidae. Proc. Zool. Soc. Lond. Pt. 1.

HOLT, ERNEST G.

1932. Swimming Cats. Jour. Mammal., Vol. 13, No. 1.

HUDSON, GEO. E.

1932. On the Food Habits of Marmosa. Jour. Mammal., Vol. 13, No. 2.

HUEY, L. M.

1932. Occurrence of Mexican Bulldog Bat in Panama. Jour. Mammal., Vol. 13, No. 2.

KENOYER, L. A.

1928. Botanizing on Barro Colorado Island, Panama. Scient. Monthly, Vol. 27.

1929. General and Successional Ecology of the Lower Tropical Rain Forest at Barro Colorado Island, Panama. Ecology, Vol. 10, No. 2.

KRAATZ, W. C.

1930. Mouse opossum Stowaways on Bananas. Science, Vol. 71. No. 1837.

KREDEL, FRED E.

1928. Note on the Temperature of the Sloth. Jour. Mammal., Vol. 9, No. 1.

KRIEGER, H. W.

1926. Material Culture of the People of Southeastern Panama, Based on Specimens in the U. S. National Museum. U. S. Nat. Mus. Bull. 134.

LAWRENCE, BARBARA

1933. Howler monkeys of the *Palliata* group. Bull. Mus. Comp. Zoöl., Vol. 75, No. 8.

MEARNS, E. A.

1907. Mammals of Mexican Boundary of U. S. Pt. 1.

NELSON, E. A.

1918. Wild Animals of North America. Nat. Geog. Soc. Mag.

OSGOOD, W. H.

1912. Mammals from Western Venezuela and Eastern Colombia. Field Mus. Pub. 155. Zoöl. Series, Vol. 10. No. 5.

POTTER, G. E.

1930. Marmosa as a Stowaway Again. Science. Vol. 72. No. 1856.

RAU, PHIL

1931. The Mouse-eating Tarantula. Scient. Mo. Vol. 33, No. 6.

REHN, JAMES A. G.

1934. A Zoölogist in the Pantanal of the Upper Paraguay. Scientific Monthly, Vol. 39, pp. 20-39.

REYNOLDS, EDWARD

1931. The Evolution of the Human Pelvis in Relation to the Mechanics of the Erect Posture. Peabody Museum, Harvard Univ., Vol. 11, No. 5.

TATE, G. H. H.

- A systematic revision of the marsupial genus *Marmosa*. Bull. Am. Mus. Nat. Hist., Vol. 66, Art. 1.

VAN TYNE, JOSSELYN

1929. Notes on the Habits of *Cyclopes dorsalis*. Jour. Mammal., Vol. 10, No. 4.

WADE, OTIS

1930. Regulation of Body Temperature in Opossums of the Genus *Marmosa*. Science, Vol. 72, No. 1867.

WAGNER, G.

1928. Banana Stowaways. Science, Vol. 67, No. 1738.

WARREN, E. R.

1928. Banana Stowaways. Science, Vol. 67, No. 1738.

WISLOCKI, GEO. B.

1928. On the Placentation of the Two-toed Anteater (*Cyclopes didactylus*) Anat. Record., Vol. 39, No. 1.
1928. Observations of the Gross and Microscopical Anatomy of the Sloths (*Bradypus griseus* and *Choloepus hoffmanni*). Jour. Morph. and Physiol. Vol. 46, No. 2.

1930. Scent Glands in Marmosets, especially *Oedipomidas geoffroyi*.
Jour. Mammal., Vol. 11, No. 4.
1931. Notes on the Female Reproductive Tract (Ovaries, Uterus and
Placenta) of the Collared Peccary (*Pecari angulatus bangsi* Goldman).
Jour. Mammal., Vol. 12, No. 2.

ZETEK, JAMES

1930. The Water Opossum — *Chironectes panamensis* Goldman. Jour.
Mammal., Vol. 11, No. 4.